The Welding Engineer

Edited by L. B. Mackenzie

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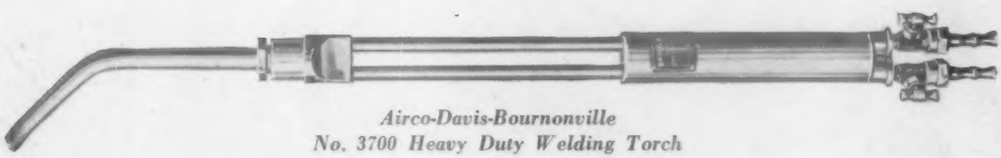
AIRCO DAVIS APPARATUS

ANYTHING AND EVERYTHING
FOR OXYACETYLENE WELDING AND CUTTING



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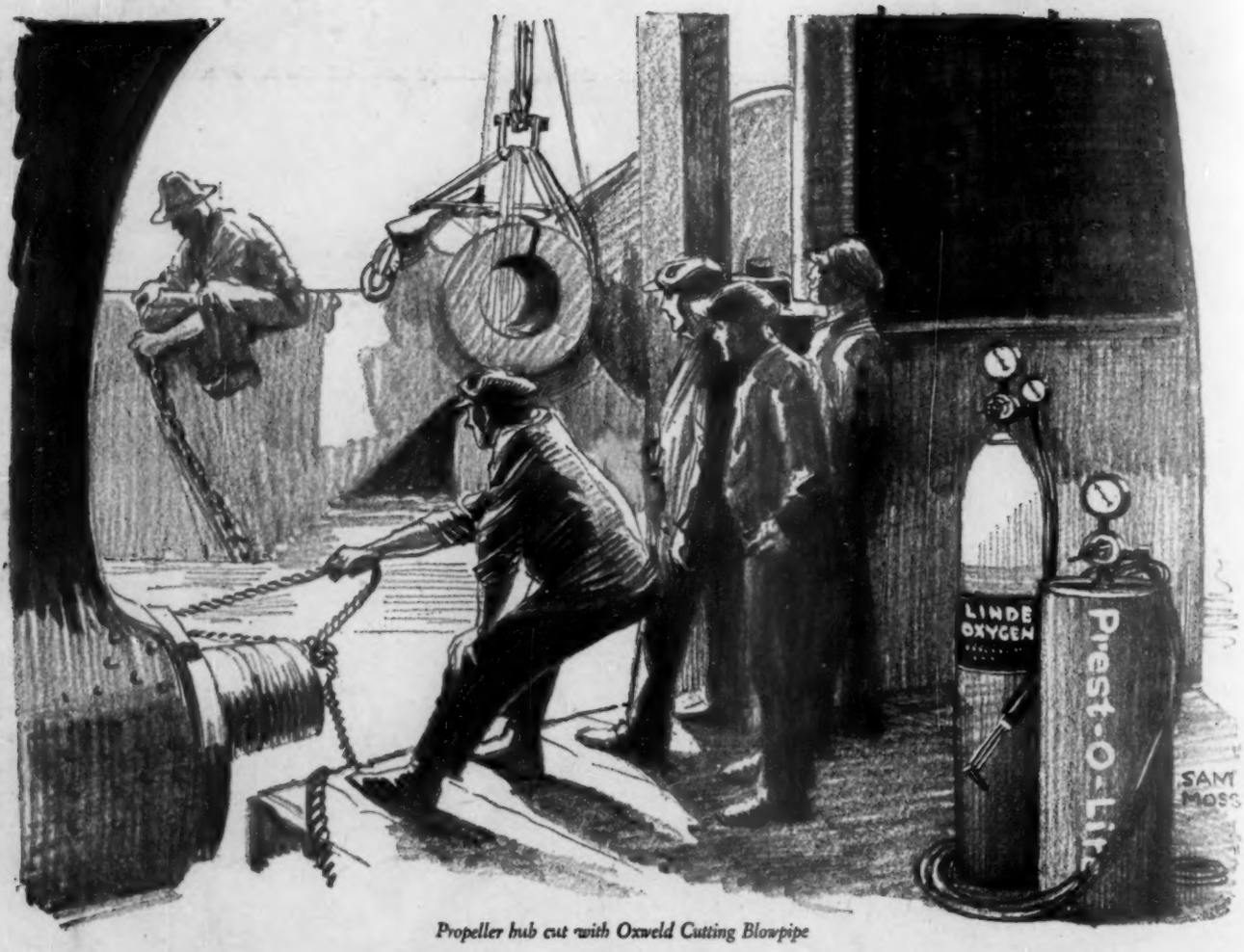

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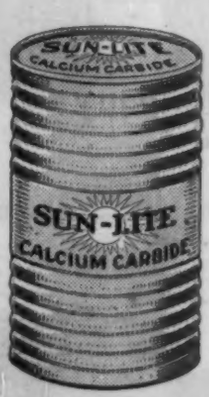

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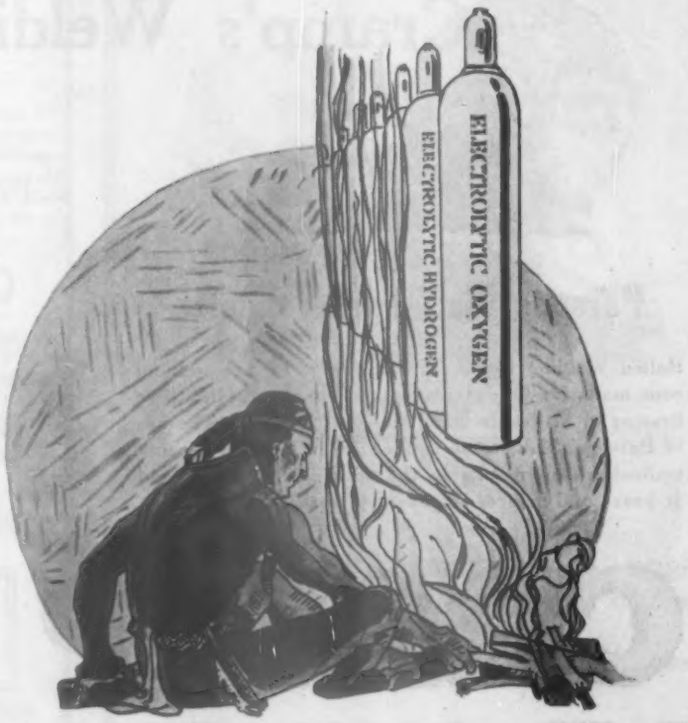

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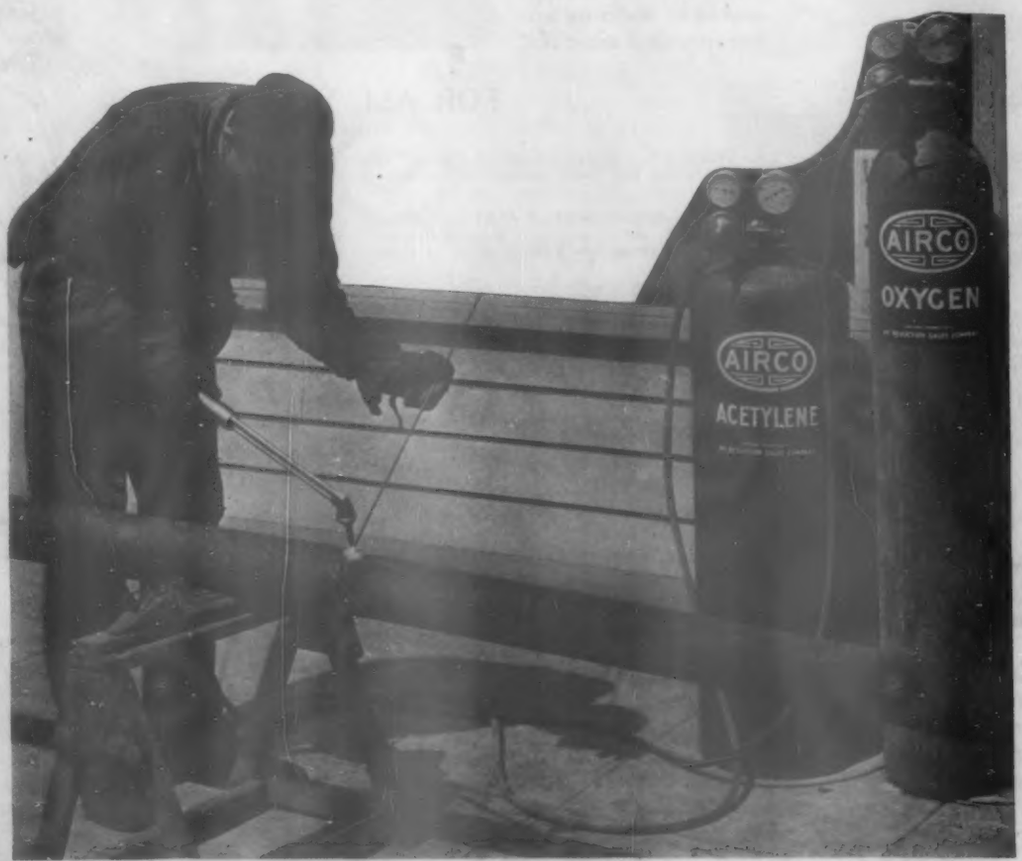

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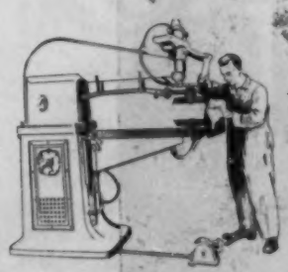

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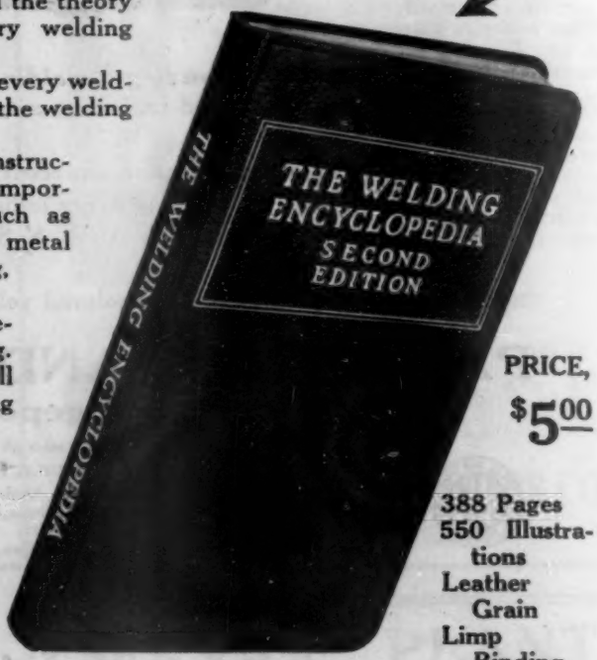

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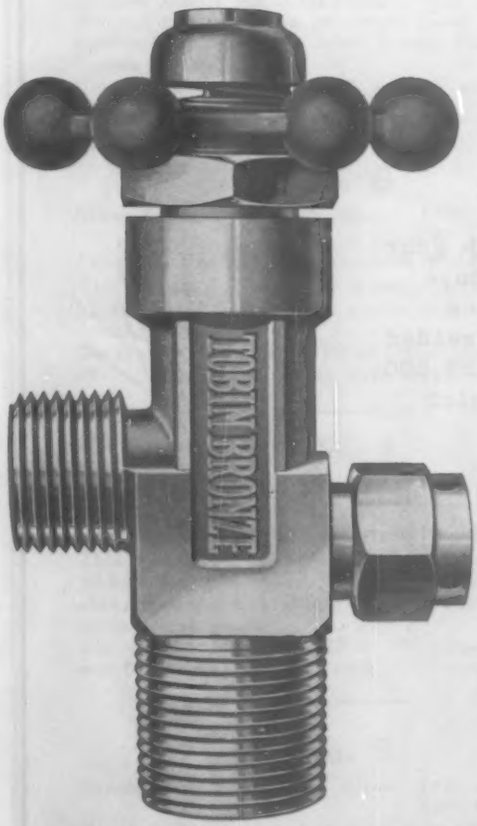

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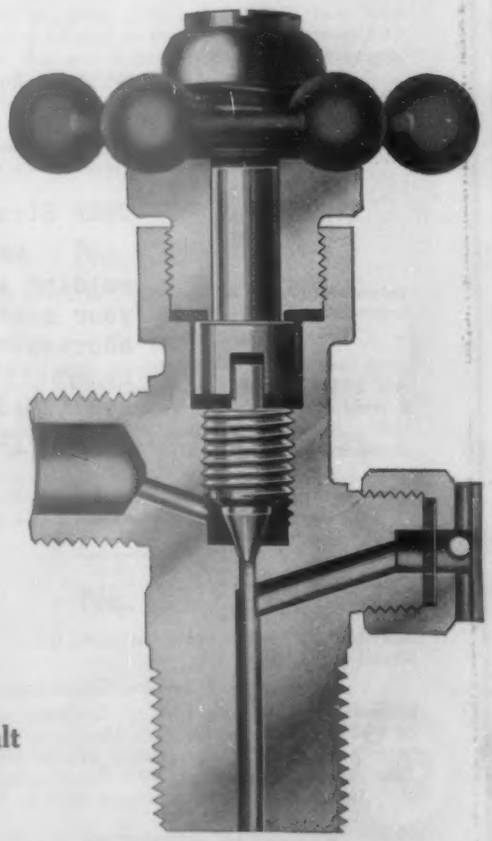

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THE PLUG, with a MONEL METAL TIP gives a positive gas-tight connection, because the monel metal tip is held in the plug loosely, giving it a swivel effect which eliminates wear on the valve seat. This makes the replacement of plugs unnecessary.

Gas users like the valve because of its easy operating features. It is not necessary to use a wrench for opening or closing the valve.

The Burdett Standard Valve is the Only Popular Priced Valve With a Tobin Bronze Body.

BURDETT MANUFACTURING CO.

309 St. Johns Ct.
CHICAGO, ILL.

Wilson "Color-tipt" Welding Metals

Nov. 13, 1922

Wilson Welder & Metals Co.,
132 King Street,
New York, N. Y.

Dear Sirs:

Am very much interested in your welding wire and hereby ask to have your metal bulletins sent to below address. On a recent test plate welded by myself your 17-120 wire stood 52,000 and 17-148 wire stood 53,500, which was the best weld of 24 tests.

Very truly yours,

Name and address of writer of this testimonial letter will be furnished on request.

FOR YOUR FILE

"Color-tipt" Metal Specifications

No. 12

Grade Color "GREY" *.148" (5/32") Diameter*
Sizes: *.120" (1/8") Diameter*
.093" (3/32") Diameter

For Flat Welding Only

This metal will penetrate cast iron and produce a homogeneous and machineable weld. Readily caulked when cold.
Current recommended 175 amperes with .148", 100 to 130 amperes with .120", 80 amperes with .093" metal and a short arc.

No. 20

Grade Color "BROWN" *.148" (5/32") Diameter*
Sizes: *.120" (1/8") Diameter*

For Flat Welding Only

This metal will produce a weld in brass, bronze and light gauge copper.
Pump Castings, Water Wheels, Motor End Rings, Tail Shaft Sleeves, Bearings, and Castings.
Current recommended Reversed Polarity 150 to 180 amperes with .148", 100 to 120 amperes with .120" metal and open circuit voltage of about 45 volts.

No. 4

Grade Color "GREEN" *Size: .148" (5/32") Diameter*

For Flat, Vertical and Overhead Welding

This metal will produce an extremely hard surface on steel and is not machineable. For use where resistance to wear is an important factor.
Guides, Rock-Crusher Jaws, Frogs, Rail Heads and Switch Points.
Current recommended 100 to 135 amperes and a short arc.

No. 6

Grade Color "WHITE" *Sizes: .148" (5/32") Diameter*
.120" (1/8") Diameter

For Flat, Vertical and Overhead Welding

This metal will produce a weld in steel of about 50,000 to 60,000 lbs. per square inch and of medium ductility.
Current recommended 120 to 140 amperes with .148" and 100 to 120 amperes with .120" metal.

No. 8

Grade Color "ORANGE" *Sizes: .148" (5/32") Diameter*
.120" (1/8") Diameter

For Flat, Vertical and Overhead Welding

This metal will produce a weld in steel of about 50,000 lbs. per square inch and is readily machineable. For use in building up worn places not subject to excessive wear.
Current recommended 115 to 135 amperes with .148" and 100 to 115 amperes with .120" metal.

No. 9

Grade Color "BLUE" *Sizes: .148" (5/32") Diameter*
.120" (1/8") Diameter

For Flat, Vertical and Overhead Welding

This metal will produce a weld in steel of over 60,000 lbs. per square inch, tensile strength and an elongation of about 15% in one inch in a mechanically sound weld. Machineable at reduced tool speed.
Automobile Frames, Boiler Plate, Cast Steel Parts, Locomotive Frames, Firebox Seams, Flue Sheet Patches, High Pressure Boiler Work, Oil, Gas and Steam Pipes, Ship Plates, Tanks, Fish Plates, and Rail Bonds.
Current recommended 135 amperes with .148" diameter, 100 to 125 amperes with .120" metal.

No. 17

Grade Color "RED" *Sizes: .148" (5/32") Diameter*
.120" (1/8") Diameter

For Flat, Vertical and Overhead Welding

This metal will produce a sound weld in cast iron where studs are used and in steel a weld of about 50,000 to 55,000 lbs. per square inch tensile strength. On steel is easily machineable.
Flue Work, Steel Castings, Blow Holes in Grey Iron Castings.
Current recommended 130 to 145 amperes with .148", 100 to 125 amperes with .120" metal.

No. 30

Grade Color "YELLOW" *Sizes: .148" (5/32") Diameter*
.120" (1/8") Diameter

For Flat, Vertical and Overhead Welding

This metal is fast and smooth flowing and will produce a weld in steel of about 50,000 to 55,000 lbs. per square inch tensile strength. For use where a smooth and rapid deposit of metal is required. Will also produce a sound weld in cast iron where studs are used.
Current recommended 125 to 145 amperes with .148", 100 to 125 amperes with .120" metal.

No. 31

Grade Color "LAVENDER" *Sizes: .148" (5/32") Diam.*
.120" (1/8") Diam.

For Flat, Vertical and Overhead Welding

This metal is particularly fast and smooth flowing and will produce a weld in steel of about 50,000 to 55,000 lbs. per square inch tensile strength.
Current recommended 100 to 115 amperes with .148" and 85 to 100 amperes with .120" metal.

No. 33

Grade Color "BLACK" *Sizes: .148" (5/32") Diameter*
.120" (1/8") Diameter

For Flat, Vertical and Overhead Welding

This metal is fast flowing and will produce a weld in steel of about 55,000 to 65,000 lbs. per square inch tensile strength with high ductility.
Current recommended 115 to 125 amperes with .148" and 100 to 115 amperes with .120" metal.

Samples on Request.

A message to every Linde Oxygen user

The Linde Company wishes to sincerely thank its patrons for the splendid spirit of helpfulness with which they have met our efforts during the past year to make Linde service of greater value than ever before.

And we pledge every man in the whole Linde organization to the task of showing day by day that we fully appreciate the obligation which the confidence and friendship of our patrons impose upon us.

For Your Convenience

Thirty plants—fifty-six warehouses

At Your Service

District Sales Offices in the following cities:—

ATLANTA	CHICAGO	KANSAS CITY	PHILADELPHIA
BALTIMORE	CLEVELAND	LOS ANGELES	PITTSBURG
BOSTON	DALLAS	MILWAUKEE	SAN FRANCISCO
BUFFALO	DETROIT	NEW YORK	SEATTLE
		ST. LOUIS	

THE LINDE AIR PRODUCTS COMPANY

Carbide and Carbon Building, 30 East 42nd Street, New York City

Balfour Building, San Francisco

THE LARGEST PRODUCER OF OXYGEN IN THE WORLD

OVERHEAD ARC WELDING

Requisites for Successful Work Are Steady Current, Free Flowing Wire, and Much Practice

By Metallic Arc

MOST welders know that overhead arc welding is always done from an exceedingly awkward and uncomfortable position, and that good results are not easily secured. In fact, welding in this position it is difficult to make a weld which will *look* good, let alone making one which will hold up under the required strain. There is no particular secret involved in securing good results on overhead welds, but any old timer knows that it is a piece of work that needs a great deal of patience and practice. Overhead work is so hard on the operator that it is always avoided when possible; that is, repair jobs are always turned so that the weld can be made in a horizontal or vertical position if this can be arranged. The bulk of the overhead welding ordinarily required, however, is in boiler work, which means that turning the work over is for the most part out of the question.

Practically all of the instructions which are usually given to an operator for overhead welding apply equally as well to welding in other positions, but the little details are so much more important as the job becomes more difficult, that care is always taken to review them. Some of the instructions which are given in the case of horizontal or vertical welding can sometimes be considered as fairly flexible when the operator is expert enough to make a few short cuts without endangering the quality of the finish weld. It is very important that these short cuts should not be attempted in the case of overhead welding, because the welder is sure to be sufficiently handicapped by the awkward position, and the difficulty of manipulating the electrode.

Quite often overhead welding is required for simply building up worn spots or other places where additional metal is required. The very first thing to do is to take the bobbing or caulking tool and remove the roughest part of the slag and foreign matter. This should be followed by the use of a sand blast. After using the sand blast the welder should be sure to go over the entire surface with a wire brush and do a very thorough job of it. This is the finish of the cleaning operation, and it is the part of the cleaning operation which is the most apt to be slighted, but it is very important to the success of the work that it should not be slighted in the least. Let the operator use plenty of energy with the wire brush because the cleaner the plate or the worn part is the easier it will be to apply new metal, and a small amount of neglect may be responsible for the failure of a job.

Keeping the metal clean has always been recognized a very essential factor in welding in any position. The welder himself is apt to give this matter very little thought, because most welders are accustomed to seeing a great deal of work started on dirty or rusty metal, and they easily get the impression that it isn't necessary to be too fussy. He has to be instructed over and over again that if he does welding on metal which is not clean, it is practically impossible for him to get thorough penetration. In the case of overhead welding on dirty metal, it will usually be found that the metal will have a tendency to flow down the electrode throwing sparks all over the welder and wasting a lot of current with the scant possibility of depositing very much of the metal where it is wanted.

It makes little difference what particular make of arc welding machinery is used, so long as it provides the right kind of current. There are several different makes and kinds of welding machinery on the market, but the alternating current, direct current, in fact all of them, have been used successfully for this class of work. The most essential thing in overhead welding is that the machine used should operate so as to deliver a constant, even flow of current. It is very difficult to get a good deposit in the overhead position when there is too much current at one moment, and not enough current the next. If there is any doubt about the ability of the machine to provide the right sort of current, some experimental welds should be made in an easier position to determine how it will act in this service. If it cannot be made to deliver the right kind of welding current, it would be better to do no welding at all than to try to under circumstances which would practically invite failure.

Although a good many different recommendations have been made as to the selection of electrode material, the welder really has only to select a wire which he knows to be free flowing and uniform. Some welders like a soft drawn wire, and others who are equally as expert, show a preference for a hard drawn wire. The reason for this difference of opinion is that each one of these has its particular talking point, and the operator selects the one which appeals most to his personal requirements.

The actual welding is a matter of manipulation, which the operator has really to acquire by himself. Before he can start to acquire them he must have served a long apprenticeship with metallic arc welding, and be thoroughly familiar with the effect of the heat of the arc on the metals he is handling, and with the characteristics of the welding current. It is possible to give a few hints which have a direct bearing on overhead welding. The operator is supposed to study these carefully, and then devote considerable time to practicing the manipulation of the electrode in the required position. This discussion aims to make clear that it is impossible to lay out a set of rules which will enable any welder to go ahead on overhead work without difficulty. The work requires great steadiness, and that steadiness cannot be acquired from the rule book.

Assuming that a piece of overhead welding is to be done on a boiler, it has already been pointed out that the very first piece of procedure is to get the parent metal absolutely clean. The welding machine is then adjusted to 130 or 135 amp. and 20 to 22 volts, and the welder is supplied with a uniform free flowing welding wire of $\frac{1}{8}$ in. diameter. Strike the arc while holding the electrode at as near a right angle to the work as possible, and hold a close arc—not too close or you will not get good penetration. About $\frac{1}{8}$ in. to $\frac{1}{8}$ in. is generally the right distance. As the electrode material flows on to the parent metal, it will be noticed that the parent metal seems to have a magnetic attraction for the metal melting off the end of the electrode, which attraction apparently causes it to adhere to the plate.*

The work must be kept as clean as possible with the wire brush, and preferably should be brushed after using two or three electrodes. The cleaner the work is kept the easier it is to make a good weld. Every welder who has tried it knows that making a weld while lying down in a cramped position is a mean job under the very best of conditions, so although the welder dislikes to stop and change his electrode for the brush, he is really making the whole job easier by going to this little bit of trouble.

When welding seams overhead, the remarks which have already been made regarding clean metal, proper welding current, and selection of welding wire are applied here with equal force. The plate, of course, should be beveled out at angle of about 45

**The theory of the method of transferring the metal in overhead arc welding is described and illustrated in THE WELDING ENCYCLOPEDIA, Second Edition, page 168.*

degrees, forming a regular V. Experienced overhead welders say that if the narrow part of the V at the very top is filled up first, it will be found much easier to fill the wide part later. It is also recommended that a ⅛ in. reinforcement of the weld should be made whenever possible, because it is always difficult to get to the other side of the overhead V, and it is always best to play safe. In fact, overhead welding is so difficult to do, and so difficult to inspect after it is done, that extreme care should always be required of the operator. The industry does not want any failures of overhead welds to occur, because if they do occur there are always some people ready to condemn the process no matter where it is applied.

There is no reason for attempting to hang up any speed records for overhead welding. In fact, fast work should not be encouraged, but any credit which is given for a good performance should be based exclusively on the quality of the weld. A good operator cannot be expected to work more than one-fourth or one-third as fast on overhead work as he can on horizontal or vertical welding. The most economical work is accomplished by slow and very careful procedure.

If difficulties develop while in the midst of making an overhead weld, that is, if the metal does not seem to flow as well as it should, and the operator sees that he is not getting a good uniform deposit, the thing to do is to stop then and find out what the difficulty is, before doing any more welding. First look at the plate and see if it has been cleaned perfectly, then take a look at the electrode and see if a piece of the wrong kind of wire has been picked up by mistake. If the plate and electrode seem to be all right, take a look at the welding machine and see whether it has been tampered with. Before starting to work again, strike an arc on a piece of scrap metal and make sure that the whole apparatus is working O. K. Don't try to go on with the weld until the cause of the difficulty has been found and corrected.

There is almost no limit to the variety of overhead arc welding jobs which can be found, and which might be described, but an investigation of the method of procedure would lead us back to the fundamental requirements for good welding: good clean metal, a good reliable welding machine which will give a steady flow of current, a uniform free flowing wire, and an operator who has been in the game long enough to be able to hold a close arc with a steady hand. Last, but not least, overhead welding is a process which requires considerable practice before the operator can be expected to turn out work which will pass inspection.

ENGINEERING AS AN AID TO WELDING

"Engineering as an Aid to the Development of the Oxy-Acetylene Process" was the title of a paper presented at the December meeting of the American Welding Society, Chicago Section, on December 8, by C. E. Ziesel, of the Oxweld Acetylene Company. The paper outlined some of the important problems of the industry which had been solved by research engineers, both in perfecting the welding process itself and in finding applications for it in the more important industries.

METROPOLITAN SECTION MEETING

The efficiency of acetylene gas welded points in pipe used for the transmission of manufactured gas through high pressure lines was brought out in a paper by G. O. Carter, Linde Air Products Company, in a meeting of the Metropolitan section of the American Welding Society, held in New York, November 13. The growth and possibilities of high pressure distribution of gas were outlined. A point of discussion was the feasibility of using testing pressures greatly in excess of actual working pressure. Successful gas and electric welded joints on steam lines, the pressures being up to 150 lbs., were cited.

"Production Welding in the Sheet Metal Shops" was the subject of a short paper by J. W. Owens, welding aid, United States Navy Yard, Norfolk, Va. The production of various thin sheet metal parts by gas welding was illustrated, the rate of output of various pieces being given.

Discussion brought out the need for adequate ventilation while welding, especially in confined places. Getting rid of fumes and protecting the health of welders was pointed out as a vital matter, worthy of research and wide discussion.

WELDING A LOCOMOTIVE CYLINDER UNDER DIFFICULTIES

When heavy welding jobs are called for in places where all the facilities for handling them properly are not available, there is a strong temptation to slight some of the work because it is too hard. The only real time-saving system, however, is to go ahead and do everything which is known to be necessary, and make allowances for the fact that the weld is being made under difficulties.

Figure 1.

Figure 2.

The welding job illustrated here was performed on a locomotive cylinder which had to be welded out in the country where the ordinary repair shop tools could not be used. The only way to chip out the bevel was to use the hammer and chisel. However, a comparison of the first two photographs will show that the trouble was taken to make a good bevel even though it required a lot of time and labor. A brick oven was then constructed around the cylinder and the whole thing preheated with oil burning preheating torches. The last photograph in the series shows the appearance of the completed weld. After the job was finished the cylinder was apparently in perfect condition, so it was put in service a couple of days later. It is reported that it has been in continuous daily service for a year without showing the slightest sign of a defect. If welders would stick to the policy of making every weld thoroughly, no matter how difficult the jobs looked, there would be fewer failures reported.

Figure 3.

Figure 4.

Iowans in Welding Session at Spencer

Oxy-Acetylene Enthusiasts Drive Miles in Below Zero Weather to Hear Discussions and Witness Demonstrations

WHAT a little town in Norehwestern Iowa accomplished, with the thermometer showing eleven degrees below zero, ought to make some of the larger cities sit up and take notice. For several weeks Mr. C. W. Rambo, sales manager of the Economy Welding Machine Company, of Kansas City, had been working with Mr. R. B. Sands, his distributor in Spencer, Iowa, to arrange for a get-together meeting of Iowa welders at Spencer, on December 12. Welders were invited from every town within a radius of seventy miles, and were promised a full day of interesting welding events, including a dinner at the Hotel Tangnoy, for a total investment of two dollars.

All night before the meeting a sixty mile wind was blowing sleet across the country, and the twelfth was a bitter cold day,

Iowa Welders Brave Sub-Zero Weather and Snow to Attend Big Get-Together at Spencer.

Left to Right: R. B. Sands, E. E. Gaddy, H. T. Montgomery, W. H. Noble, R. L. Hopkins, H. Zandt, H. Ullmer, C. W. Rambo, L. B. Mackenzie, Mr. Jensen, A. Sherbondy, Mr. Anderson, Welder from Melvin Auto. Co., T. A. Hersleff, E. W. Hays, E. L. Merchant, W. F. Pavey, Welder from Hastings & Mattice at Primghar, Paul Kaplan, N. C. Simonson, O. Meyerdirk, H. James, Mr. Larson, M. Keenan, R. F. Twist, Welder from Mattice & Hastings at Primghar, Welder from Milford Garage, John Aich.

yet nearly forty of the welders from surrounding towns drove in for the event. This illustrates the influence of good service work on users of equipment. The Spencer Welding Works has been devoting a lot of attention to service work in the neighborhood, with the result that there has been an unbelievably small percentage of failures on the part of a hundred or more welders in that section. Mr. Sands, manager of the Spencer Welding Works, states that their efforts in the way of service work have produced orders for twenty-five additional individual installations since they started it, and about a dozen generators have been sold in the same period. This is a splendid showing when it is known that business conditions in this section of Iowa have been especially discouraging, on account of the high price of land, high taxes, and dearth of manufacturing.

The program of this meeting differed from the usual program in that the banquet was held at noon. The forenoon was devoted to getting acquainted, and to a few demonstrations of welding methods at the Spencer Welding works. Fortunately Spencer boasts one of the finest hotels in the state, so the crowd was comfortably fed after the program of speeches finished. Mr. Perry, president of the Spencer Chamber of Commerce, opened with an address of welcome, and was followed by Mr. A. H. Avery, another member of that lively body and an optimist if there ever was one. Welding talks were made by C. W. Rambo, R. B. Sands, L. B. Mackenzie, Editor of THE WELDING ENGINEER, Chicago, H. T. Montgomery, of the Union Carbide Sales Company, and Mr. H. Ullmer, of the Oxweld Acetylene Company.

The closing number of the meeting was a series of demonstrations of flue sheet welding, boiler patch welding, heavy cutting, aluminum welding, cast iron welding, and the welding of a cast iron gear wheel. These demonstrations and the accompanying discussions furnished the welders with solutions of a number of their most common welding problems.

Following is an extract from Mr. Ullmer's paper, which points out some of the possibilities of extending the use of welding.

"In thinking of the advantages of a high temperature flame we must keep in mind what happens when the article to be heated is brought into contact with the means of heating, which means that a certain amount of heat is added.

"Another advantage of oxy-acetylene in addition to its quick heating is that it is so concentrated as to be adaptable to permit the applications of the heat to bend parts which are installed in machinery assemblies and would have to be otherwise dismantled.

"It is a well-known fact that automobiles are constantly having fenders, goose-necks, axles, etc., bent, and it has been found that the oxy-acetylene torch can be used for local application of heat so that the body does not have to be taken off of the chassis which would be necessary to permit straightening by other means. Farm equipment such as sowers, hay racks, threshing machines, etc., is constantly requiring the blacksmith's services for straightening bent shafts, and this usually requires the taking apart of the machinery, whereas a welding torch could be applied to the bent shaft, which, when heated red, could be straightened by a few blows of a hammer or sledge.

"Having discussed three different processes which should be considered under the head of oxy-acetylene applications, it may be well to consider the best method of applying the processes, because the oxy-acetylene torch can be very readily carried to the work as well as being applied in shops. The portability of outfits employed in applying the oxy-acetylene process is one of its best qualities for certain kinds of work, but there are special cases where this same portability involves some of the most serious problems connected with the industry.

"If we so desired, it would be feasible to use the oxy-acetylene equipment wherever a breakdown occurred, carrying the apparatus and gases in preference to carrying the work to a repair station. This is very useful in the repair of boilers and some forms of very heavy machinery. The apparatus can also be kept at some

convenient point where appreciable quantities of equipment require occasional repair. This involves intermittent use of the oxy-acetylene processes, but sometimes saves a great deal of operating time for machinery which would otherwise be out of service for a considerable period.

"A road contractor who has quite a lot of equipment in the way of concrete mixers, trucks, excavators, stone crushers, etc., could well afford to have a complete oxy-acetylene outfit at some central point so that it could be rushed to any place where serious trouble had been encountered through breakdown of machinery or equipment. At times the breakdown of one piece of machinery ties up a whole gang and then becomes a very costly matter. In big manufacturing plants, such as steel mills where the output is dependent upon the rolling capacity, a large mill is rated about $1,200 an hour. The use of the oxy-acetylene cutting torch permits the severing of nuts in a matter of minutes, where it frequently takes hours to remove the nuts by sledging; therefore, the master mechanic of a big mill keeps the oxy-acetylene cutting equipment always near at hand. The saving of one hour more than pays for a complete oxy-acetylene cutting station, and it is safe to say that every mill has used its cutting equipment on numerous occasions.

"Big mills where values run so high would naturally be the first to sieze upon an aid like the oxy-acetylene process, but the same problems which confront the big mill confront industry in general, and it might well pay many users of machinery to study the possibilities of the oxy-acetylene cutting torch for quick removal of nuts, which can be severed without damaging the bolts to which they are attached; the straightening of bent parts, possibly without complete removal from assembled equipment; the repair of broken castings near where the work is going on, etc.

"The oxy-acetylene cutting torch can be used with as little difficulty in the open as in a shop, but it is the belief of the trade that better results will be obtained in welding if the work is done under the best possible conditions. This is particularly true of the repair of castings, where preheating furnaces may be required, and where it is important to keep currents of air from striking the hot metal, with the resulting contractions and possibly the development of new cracks. So, although the portability of the oxy-acetylene equipment may be advantageous where even a short shutdown would run the costs for the damage into very high figures, it would probably pay to have broken machinery parts. removed to a repair welding shop where the work would be handled in a manner very similar to the way it would be taken care of in a machine shop, except that the welding operation would be carried on rather than a machining operation.

"In all of the possible uses of the process it is up to the user to study the conditions and to make the best applications of the process. If a user is running a repair shop and he knows that considerable work should be brought into a shop, where is would be done under the proper conditions and with all the necessary facilities, he should try to get those attempting to use portable outfits to appreciate the situation and bring the work to him. With most individuals this is a matter of dollars and cents, but the quality of the work is one of the most important factors in determining costs, and if a man can be shown that better results are to be obtained by having his welding work done in a shop, even under higher initial charges, he will be very apt to turn a good deal of his work over to the repair welder. On the other hand if breakdowns are apt to be of a very urgent and expensive nature, it is probable that the repair welder should advise the prospective user so that he can properly equip himself with an emergency outfit.

"It is probable that within a few years the oxy-acetylene welding and cutting processes will be used extensively on big farms and wherever construction work is going on, as well as in factories.

"The welding process can be abused, however, and one of the things which is apt to delay the day when the process is almost universally used is the risk of those who are not competent welders undertaking work which might seriously endanger themselves or others.

"It is a very simple matter to check the ability of a welder to do satisfactory work. If a sample of his welding is put into a vise with the welded surface level with the face of the vise and the welded sample be bent by repeated blows of a hammer, any defective workmanship will show up by the piece breaking through the weld, showing the defect. If, on the other hand, the sample may be bent 90-degrees without its showing serious cracks, it is safe to assume that the welder knows how to obtain good fusion and that he has made a joint which would stand up in service alongside of the best rivetted joints. This test is primarily one to check the welding of sheet metal and pipe. The welding of cast iron can be checked by the same test, except that cast iron is sure to break without appreciable bending, but the character of the fracture will plainly show whether the weld is clean or is full of blowholes, which are very objectionable.

"Another thing to remember about the permissible use of welding is that welds can be checked by subjecting the finished work to real tests. If the work can be put under an internal water pressure, such as is possible with welded pipes or tanks, a good factor of safety such as 2 to 1 should be allowed; then the welds should be further tested by hammering the metal close to the welds, which will show leaks, if defective. Of course, water should always be used in the pressure-impact test described above and all air or gas must be carefully drained before the test, otherwise if the material failed under test someone might be injured. Another test which is quite satisfactory is the kerosene test, wherein one surface of the weld is chalked and kerosene is poured or painted on the other surface. If there is lack of fusion the kerosene usually shows through on the chalked surface within 10 or 15 minutes after it is applied to the other side.

"I cannot add anything more fitting to the final picture of the modern blacksmith and welder than to tell you about a certain blacksmith in one of the smaller communities in Nebraska who is using the torch to reclaim worn-out plowshares. It is a safe venture that everyone in this assemblage is familiar with the rusted, cast-away plowshare. It is found in fence corners and scrap piles all over this section of the country and in every other section where there is farming. Some of them are broken and some of them are simply worn so badly that it does not seem practicable for the blacksmith to repoint and retemper them in the old way. This blacksmith of whom I sepeak was one of the first to add welding and cutting equipment to his shop. He figured that he was the logical user of the process because he had worked with metals all his life and knew how to handle them under practically every condition that could possibly arise on repair work. He found the welding and cutting torches almost like his A, B, C's to learn. With the enthusiasm of a discoverer he looked about him for places where he could use the three processes —welding for joining and building on; cutting for speeding up the severing of metals, and heating for hending, straightening and removing dents.

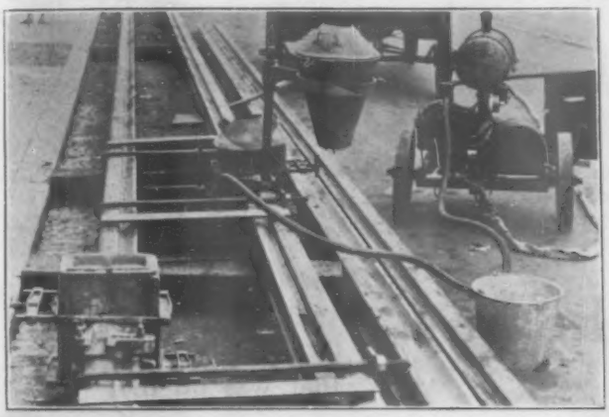
"The idea of building up plowshares, retempering them and restoring them to service after they were quite beyond salvage by the old blacksmithing methods appealed to him. He started with a few jobs which he handled purely as experiments. Now, as all of you know, word traveled fast in the country even before the days of the telephone and automobile. With these facilities for rapid communication as we have them today it is not surprising that the neighbors, both near and distant, soon learned of the success of reclaiming outworn plowshares. They might have heard just as rapidly had the blacksmith welder fallen down in his effort, for it is human nature to love a joke, and the joke would have been on the blacksmith who bought a welding outfit. Today the joke seems to be on the blacksmith who stands pat with the equipment he put in fifteen or twenty years ago, and who tries to stem single-handed the tide of progress which is sweeping the land industrially. It can't be done. The up-to-date blacksmith will be an oxy-acetylene welder and cutter, and by the token of his fitness to excel he will be an expert in the use of his equipment and in meeting and solving problems that would stump less practical operators."

INSTALLING PRE-WELDED RAILS

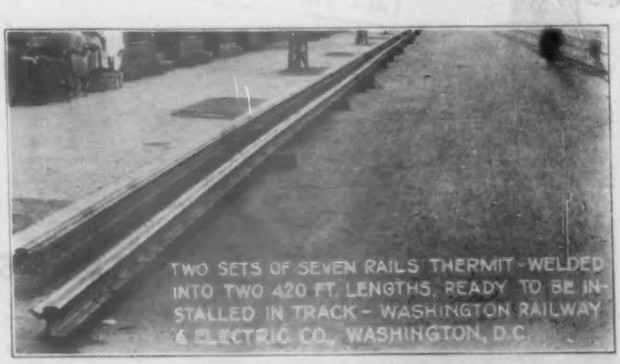
Making Rail Joints Before Track Is Laid Saves Traction Company Many Dollars on One Job

DURING the course of some track relaying work the Washington Railway & Electric Company, Washington, D. C., recently adopted an economical method of installing and Thermit-welding new rail at a considerable saving in time and cost as compared with the usual method of procedure, yet without interruption to traffic.

This company planned to replace 7,000 ft. of fourteen-year-old double track on H. Street, between North Capitol and Fifteenth Streets, N. E., Washington, with new 6-in. L.S. Co. 120-513 Trilby rail, a special rolled section, which is a modified A. E. R. E. A. rail, made to conform to the special requirements of the conduit current distribution system installed in Washington. Normally three to four-minute headways are maintained over this line, with one to two-minute headways lasting about 2½ hours, both in the morning and the evening, during rush hour periods. In addition to this service the heavy interurban cars of the Washington, Baltimore & Annapolis Electric Railway also operate over these tracks. It was, therefore, important that this frequent car operation be not interrupted. There were no adjacent, parallel lines over which to re-rout car traffic during rehabilitation, and the construction of temporary crossovers was entirely out of the question because of the difficulties and expense entailed by the conduit system.



Rails Prepared for Welding.


TWO SETS OF SEVEN RAILS THERMIT-WELDED
INTO TWO 420 FT. LENGTHS, READY TO BE IN-
STALLED IN TRACK - WASHINGTON RAILWAY
& ELECTRIC CO., WASHINGTON, D.C.

Two of the 420 Ft. Lengths.

The only time for carrying on this work without interrupting car traffic was between 1.30 and 5.00 a. m., during which period a half-hourly "Owl" service was maintained by one car, which could be routed back and forth on one track, while the other track could be torn up. But relaying track over a conduit system takes longer than in the case of ordinary track for the following reasons:

(1) Instead of simply spiking the rail to ties each rail must be bolted with four hook-bolts to the conduit yoke seats which support the rails at 5-ft. intervals.

(2) The yoke seats allow less room than ties for lateral adjustment of the rail.

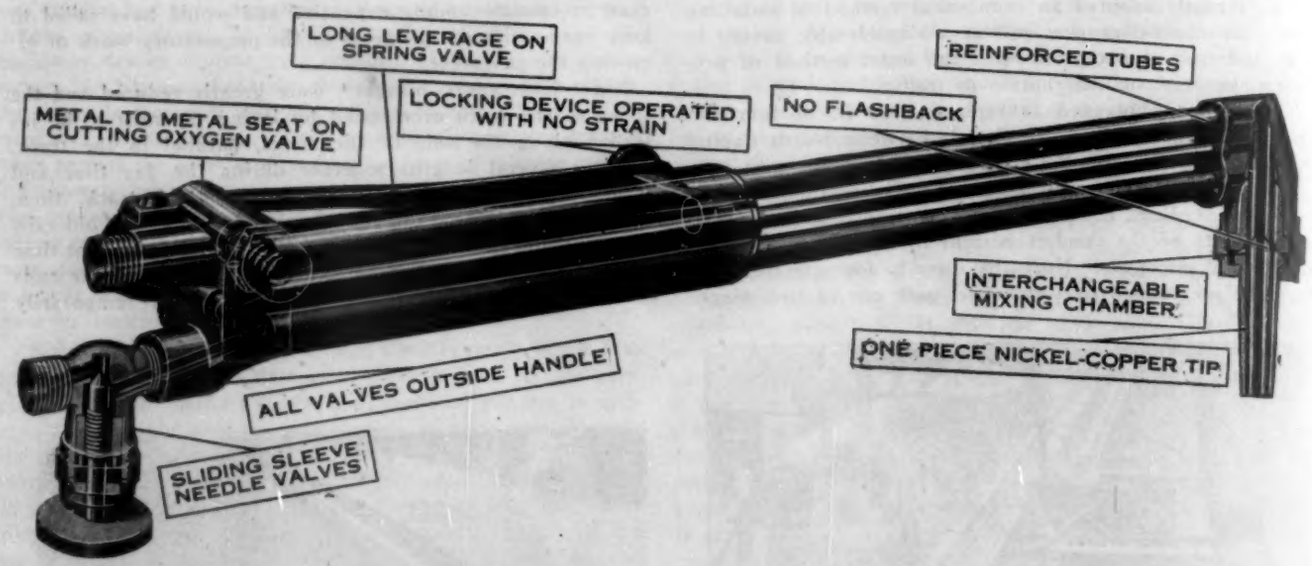
(3) The rails of a conduit system have to be surfaced much more carefully, by inserting steel filler plates between yoke seat and rail base (rather than tamping material under the ties, as in ordinary track) in order not to cause misalignment of the plow contact shoe, and hence possible breakage of the porcelain and cement insulators from which the conductor rails are suspended.

For these reasons, therefore, also because of the short, costly and ineffective periods of night labor the work threatened to become unduly expensive and would have failed to keep apace with the progress of the preparatory work of removing the pavement.

Night labor costs, however, were greatly reduced and the speed of the work accelerated by laying the rails to be installed along the side of the street, parallel to the track, welding several lengths together during the day time and transporting them close to the edge of the track, then, during the early hours of the morning removing the old rails and installing the new welded lengths. If there was not time to weld the free ends of the welded rail lengths to the ends of the rails already installed, these joints were temporarily bolted, and Thermit-welded on another night. The new rails were temporarily bolted to every fifth yoke seat, or at intervals of 25 ft. Except where especially low joints occurred, surface plates were not inserted until later during a day period, when the temporary bolts were removed, the base of the rail wedged, plates inserted and the rail base bolted permanently to the yoke seat.

The number of rails per unit to be first welded together at the side of the street depended on the length of space uninterrupted by cross-streets along the curb adjacent to the place of installation. In most cases these welded rail lengths included three or four 60-ft. rails. In one case, on H Street, between Twelfth and Thirteenth Streets, a pair of rail lengths each was comprised of 7 rails, making continuous lengths of 420 ft. each (see Fig. 2).

Before welding the rails at the side of the street each set of rail lengths were mounted on wooden cross ties cut in half, lined up parallel to each other and carefully surfaced by placing shims under the joints to be welded. The rails to be welded were kept in accurate lateral alignment by spacing the parallel rails evenly apart by means of three sections of I-beams, as shown in Fig. 1, which were cut to similar size, and clamping the rails together with eight bolts, four of which were clamped around the rail heads and four around the rail bases. Welding was then performed by the Thermit insert welding process. After the welds were made the welded rails were removed from the blocks and replaced by a set of unwelded rails.


LONG LEVERAGE ON SPRING VALVE
METAL TO METAL SEAT ON CUTTING OXYGEN VALVE
LOCKING DEVICE OPERATED WITH NO STRAIN
NO FLASHBACK
REINFORCED TUBES
INTERCHANGEABLE MIXING CHAMBER
ONE PIECE NICKEL-COPPER TIP
ALL VALVES OUTSIDE HANDLE
SLIDING SLEEVE NEEDLE VALVES

This Is the Boy

that was on that job *so early* in the game and ***remained*** right with it till that pile was no more.

Try them — they can be absolutely depended upon for

Proper mixture—
No back fire—
Not heating up—
Not requiring any attention.

It's the torch that stands hard, continuous work.

Have you our catalogue No. 23W?

The BASTIAN-BLESSING COMPANY

West Austin Avenue at La Salle Street
Chicago, Ill.

This page reproduced from the November, 1922 issue of the Welding Engineer

In this case the steel structure and the machinery had been twisted and melted together to such an extent that it would have been impossible to have moved the wreckage away without cutting it up into small pieces. It was situated on a piece of ground which was badly needed for continuing the manufacturing activities, and the owners of the building were desirous of erecting a new structure at the earliest possible date, so that production could be continued. A part of their reg-

One Corner of the Wrecked Plant.

ular equipment was a portable oxy-acetylene welding outfit, and the welder being familiar with the possibilities of oxy-acetylene cutting was able to guarantee that a cutting torch would go through that pile of scrap in short order. To get it done in the shortest amount of time, he secured a crew of five oxy-acetylene cutters who were put on the job, and an extra supply of acetylene and oxygen was rushed to the spot. These men started at one corner of the old factory site and proceeded to work toward the other corner, cutting off pieces small enough to be lifted and carried by eight or ten men. Box cars were backed up on a switch adjoining the factory, and a crew of men were kept busy carrying the pieces out and loading them on the cars as fast as they could be cut loose from the pile. The metal was so tangled up and there were so many pieces to be cut in different positions, that it was impossible to secure the speed and efficiency which might have been possible on straight cutting. The cutters were obliged to climb through the pile and drag the hose with them into out of the way places, then, after [illegible] move on to some other equally hazard[illegible]. The fact that it took several [illegible] reducing the wre[illegible] handled [illegible] The [illegible] for [illegible] a[illegible] belt [illegible] ters tha[illegible] helped him [illegible] tip was replace[illegible] to weld his own leg. This piece [illegible] was entirely successful, and he was back on the job in thirty minutes after the accident occurred. The oxy-acetylene process is not universally recommended as a surgical instrument, but in this case the operation was made possible by the fact that the cutter had broken his wooden leg instead of his own leg. The steel hinge which gave way when he fell is still giving good service.

Important Notice

the torch cutting equipment used so effectively to clear up this fire was the celebrated REGO—made by

The Bastian-Blessing Company,
Chicago, Illinois.

Close-up View Showing How Badly the Fire Had Twisted the Steel Structure.

Acknowledgment is made to Mr. Geo. D. Purdon, of the Commercial Acetylene Company, and Mr. E. D. Findlay, of the Acme Oxygen Company, for co-operation in supplying photographs and information regarding this interesting cutting job.

ADV.

When the time came for transporting the welded rails to the edge of the track, gangs working on 4-man rail tongs lifted them over. In the case of the 7-rail lengths, 20 men on 5-rail tongs were used, with 5 men prying the rail with slot bars, making 25 men in all. Efforts were concentrated on moving only one portion of this flexible unit at a time by successively shifting one end, then the middle, then the other end, halfway across the street. By repeating these operations once more the total lateral shift of about 18 ft. from curb to track was completed. The two 7-rail lengths

Shifting the Rails Laterally with Rail Tongs.

were thus shifted laterally in ¾ hour. Each multiple unit was then, in turn, placed on pipe sections as rollers and tugged along parallel to the track by means of a Fordson tractor to a position next to where it was to be installed. In future low dolly trucks, equipped with center wheels of slightly longer diameter to facilitate free changes of direction, will probably be substituted in place of the pipe sections.

Pulling Rail into Position with Tractor.

Only a few minutes were required the following night for 7 rail-tong teams to place the 426-ft. rails upon the yoke seats and bring one end flush with the rail already installed by battering the other end with a loose rail.

This reconstruction work was in direct charge of George Mahoney, Supervisor of Construction, and under general supervision of H. Jackson, Supervisor of Underground Lines. The welding gang included a welding crew and a grinding crew, both under one foreman. Duties were arranged as follows:

Welding crew (6 men).

1 man for making molds.
2 men for aligning, surfacing and clamping rail.
2 men for applying molds, preheating and pouring.
1 man for removing and cleaning up molds, also other cleaning up work.

Grinding crew (5 men).

2 men on one grinder, grinding head of rail.
2 men on a second grinder, grinding weld at gauge line.
1 man on small hand grinder for finishing off grinding work.

The cost of Thermit welding rail joints on this job, up to and including Aug. 8, 1922, was as follows:

	No. of Joints Considered	Labor Cost Per Joint	Material Cost Per Joint	Total Cost Per Joint
1. Welding	105	$2.88	*$8.13	*$11.01
2. Thermit supplies and equipment (not including materials actually used up in welding)	500	.....	.55	.55
3. Manufacture of rail clamps and blocking for rail (for using special welding method described)	500	.41	.22	.63
4. Extra handling of rail (for using special welding method described). Putting rail on blocks and removing after welding	170	1.33	.....	1.33
5. Grinding (estimated only, because work not completed at this time)	.....	1.00	.50	1.50

Note A.—Practically speaking, should additional welding be contemplated the cost of Items 2 and 3 would actually be much lower, as these materials will still be serviceable for additional work at the completion of this job.

Note B.—As the work progresses the unit cost of Items 1 and 4 will be considerably decreased as the welding crew becomes more expert in applying the new method.

*Had the new "Center Pour" Thermit insert weld been used, the material cost of welding per joint would have been only $5.50 and the total cost of welding per joint $8.38.—Reactions.

SERVICE TEST BREAKS DRAW BRIDGE SHAFT OUTSIDE OF WELD

In 1920 an emergency Thermit weld was made on a 6" diameter pinion shaft used for turning a large draw bridge in North Chelsea, Mass. After 2½ years of service operating the draw bridge, this pinion again broke but in a location well

An Emergency Weld Which Gave Over Two Years' Service.

outside the weld as shown in the illustration. An idea of the service test to which the weld was subjected may be gained by the fact that the starting torque transmitted through this pinion shaft was 520,000 lbs.

WELDING REPAIR ON TANK BOTTOM

Welding Method Proves Cheaper and Quicker Than Previous Methods Used for This Kind of Repair

CONSIDERABLE publicity has been given to the subject of welding oil storage tanks in the last two or three years. There seems to be no limit to the size of tanks which can be welded by either the electric or oxy-acetylene processes, and the advantages of the welded tank from the point of view of the enormous saving through the prevention of leakage are becoming so well known that the riveted tank is well on the way to becoming obsolete construction.

Welding repairs on tanks while in service are fairly common, but once in a while a repair of unusual character is reported. For example, the photographs shown herein were taken when the Empire Pipe Line Company, of Tulsa, Okla., used electric welding to repair the bottom of a large storage tank. The company made tests of the electric welding process and have found it a quick and economical method of repairing defective bottoms of large steel storage tanks for crude oil. This is the first repair on a tank of so large a capacity as 55,000 barrels which has been reported. It was done on the Boyer Farm near El Dorado, Kans., by the Welding Engineering Company, of Bartlesville, Okla., of which Mr. H. C. Price is manager. The repair was made late last summer, and according to all reports the tank has been holding crude oil and meeting other requirements of the engineers of the Empire Pipe Line Company since that time.

Left—Exterior and Interior View of Tank. Center—Welder at Work. Right—One of the Welded Seams and a View of the Equipment Used.

The decision to make this repair by welding was arrived at only after an extensive investigation had been made to determine the most efficient and economical way of making repairs on this type of tank. All of the various welding methods were considered, and bids were asked for from concerns who used different methods. In each case the contractor was requested to give a statement of the method by which he proposed to use the metallic arc welding process, using a standard type of machine and a coated electrode.

Specifications called for the welding of all seams and all rivets, the filling of all holes where rivets were missing, and the building up of worn and pitted spots on the tank bottom with welded patches. There were 2,876 feet of seams and 22,936 rivets were to be welded. The work consumed 1,100 pounds of welding wire.

Before doing any welding at all, it was necessary to remove a section of the tank wall. The tank bottom was then cleaned of all muck and scrubbed with wire brushes. A final cleaning of the seams and rivets was made with a sand blast.

The welding generator was set up outside the tank and connected to a 40 h. p. Hercules gas engine and well covered to protect it from rain. Two welding lines were run into the tank, since the generator furnished enough power for two welders to work at the same time. After the first preparations were completed and the welding generator put into operation, it was kept running from 12 to 20 hours a day until their work was completed. When all of the inside work had been done the section of the tank wall was put back in place and the tank was tested by the standard methods used for testing of tank bottoms when they are repaired by the old-fashioned methods. First, enough water was pumped in to "wave" the bottom, then it was filled with water and left to stand. It did not require much time to establish the fact that no leaks had been left in it, so it was filled with oil. It has been in constant use ever since.

The Empire Pipe Line Company were so well pleased with the result that it was decided to use welding for all future repair work of this nature whenever the circumstances indicated that it would be desirable.

Tank bottoms of big storage tanks formerly were repaired either by replacing the bottom with new steel or by replacing with concrete. To install new steel made it necessary to take off the tank top and cut down the shell. Concrete repair work was accomplished by placing a reinforced concrete slab, protected by asphalt, on a concrete base, for the new bottom. In the present case it was found that the electric welding method proved both cheaper and quicker than by replacing by new steel, and more economical than rebuilding the bottom with concrete.

The U. S. Bureau of Standards is now conducting an investigation to determine the strength of rail joints welded by the different processes.

The Wilson Welder & Metals Company has just completed a repeat order for welding machines for the Polish State Railways, making a total of thirteen machines supplied for this railroad.

The Welding Engineer

Reg. U. S. Pat. Office.

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This Outfit Will Be Needed in 1923.

NEXT year will probably see more welding done than ever before. A logical basis for this assumption can be found in the fact that every oxygen plant in the country is working to full capacity and additional plants are contemplated. There surely will be some corresponding advances made in the manufacture of equipment. The time is ripe for someone to develop a complete welding shop on wheels. Such an outfit would include motor truck, gasoline engine, arc welder, air compressor, portable grinder, pneumatic chipper, sand blast, oxy-acetylene welding and cutting apparatus, oil burning preheaters, and the necessary supplies of wire, flux, etc. A demand for such a complete portable unit has existed for some time, and has usually been filled by hand-pick assortments of machinery. A ready-to-use outfit would be welcomed by job shops, railroads, lumber camps, foundries, gas companies, refineries, and others, as an accessory to the central welding shop.

Iowans Set the Example.

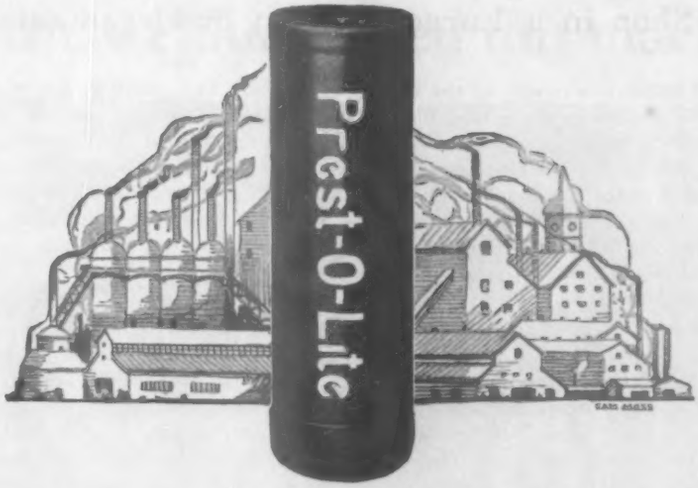
WHEN a meeting of welders in an isolated town in Iowa, the town itself boasting less than half a dozen welders, can draw attendance from towns thirty miles distant through below zero weather, it is a hopeful sign that interest in welding meetings can be aroused. The promoters of the meeting at Spencer knew how to get an audience, and how to build a program. Here was a case where real enthusiasm and real effort produced a real success. Section meetings of the American Welding Society can be made just as successful on a larger scale because the sections have larger bodies of men from which to draw crowds. A program of promotion, identical with that used for the Spencer meeting is being presented to men who are supposedly interested in building up sections. It will be interesting to observe whether the program will be supported by genuine action or by dignified nods of approval. Let's not nod too much in this membership work. Nodding is usually an indication of rapidly approaching slumber.

The Bronze Filler Rod.

WELDERS will maintain that the brazing of cast iron is impossible and impractical, and that it should not be encouraged. In taking issue with that viewpoint it should be made clear that the best users of the bronze rod recognize the superiority of a welded joint over a brazed joint. But they have learned that in frequent emergencies brazing serves the purpose and is at the same time the most expedient repair. A story is on the way of a bronze repair on a locomotive cylinder, which used 175 pounds of bronze filler rod, made by real welders. The engine is now pulling about seventy freight cars over the line every day. The live welder will not wait until the last minute to find out how to do this kind of work. He'll get right busy and experiment until he is prepared to turn out a good braze on cast iron when the emergency arises.

Faith That Will Move Mountains.

A REGULAR church-going welder describes a particularly difficult welding job on which no less than twenty-five welders were tried, before one was found who could weld it. Someone must have had infinite faith in the process to have been able to talk the owners into another trial after twenty-four straight failures. More power to his preaching, and may he always be supported by an able welder in the future. The percentage in this case indicates that it is still necessary to test them.



The one gas for both cutting and welding

Acetylene is the *one gas* perfectly adapted and in general use for the cutting and welding of metals.

Today it stands as the *only practical welding* gas and *by far the best for cutting*, despite continuous efforts to substitute other fuel gases.

Its use does away with the necessity of two stocks of gas and two types of apparatus—one for cutting and one for welding—thus enabling operators to do quicker and better work, and simplifying problems of management.

In Prest-O-Lite Dissolved Acetylene you have this finest of fuel gas at your command in a portable form—safe, convenient, economical and dependable.

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Each Prest-O-Lite user looks to his nearest District Sales Office not merely for arrangements to adequately cover acetylene needs, but for helpful cooperation and advice on any matter involved in the use of acetylene.

Prest-O-Lite

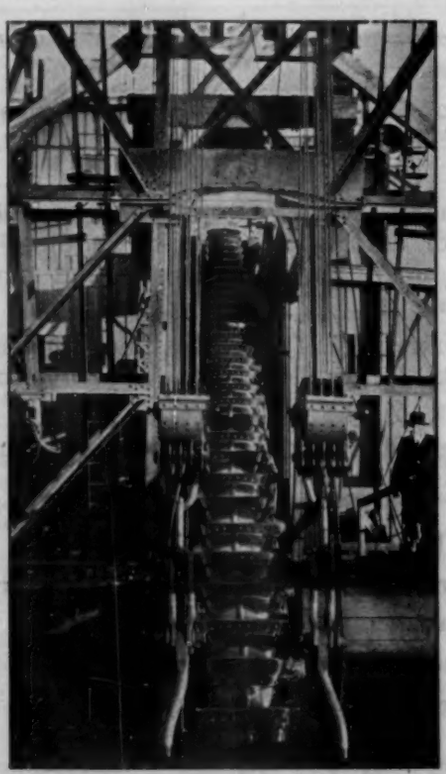
DISSOLVED ACETYLENE

Welding and Cutting at Anaconda

Illustrating the Value of a Central Welding Shop in a Large Industry or Organization

THE Anaconda Copper Company was one of the earliest users of the oxy-acetylene process in the mining industry, and it is one of the largest users of gas welding and cutting in the mining field today. This is true not alone of the lump volume of work done, but also of the variety of applications. For this reason, the well-seasoned experience Anaconda has gained in the use of welding and cutting should be highly suggestive of what can and should be accomplished elsewhere in the mining and smelting field.

The fact that the oxy-acetylene process is almost universally employed at mines and mills by no means indicates that its use has reached the saturation point. It means, rather, that it has reached a great many valuable starting points, with every opportunity for tremendous development. Only comparatively few, even of the very great mining and smelting corporations, employ the process to anything like the extent that those would if those in charge of operations and equipment better understood the range of applications that is possible under favorable conditions.



Manganese Lips are Welded on These Buckets.

There is a certain disadvantage in reviewing welding and cutting at Anaconda, in that the vast extent of the company's mining and smelting operations may give the impression that only very large industrial organizations have extensive uses for the process. Such a conclusion would be entirely wrong. The extent of oxy-acetylene applications is not to be measured altogether by tonnage or general plant facilities. There are other factors involved, such as managerial understanding of the possibilities of welding and a knowledge of apparatus and plant requirements. At properties where welding and cutting are regarded merely as emergency measures and only portable and limited equipment is available, the uses of the process are certain to be restricted to a narrow range. On the contrary, wherever operating executives appreciate the importance of oxy-acetylene department, even if it is relatively small, which is housed in a properly equipped central shop—the range of uses is very much more comprehensive.

At Anaconda the central welding shop is equipped with a stationary 500-lb. carbide capacity duplex-type, low-pressure acetylene generator for shop use. In addition, a 100-lb. carbide capacity portable generator; four 50-lb. carbide capacity portable generators; forty-eight 300-cu. ft. capacity acetylene cylinders; twenty-four 100-cu- ft. capacity acetylene cylinders; and sufficient oxygen cylinders available for outside or field operations. Cutting and welding blowpipes, gas regulators and other accessories are part of the shop equipment with which to maintain a force of from fifteen to eighteen welders and cutters. The shop itself is also provided with all necessary preheating and annealing ovens and modern cranes for handling the heaviest castings and mechanical parts. The central welding shop has a pipe system which conveys oxygen from the manifold room and acetylene from the generator house to a large number of stations or points in the shop where welding and cutting are carried on, thus affording even facility for efficient handling of work. All heavy work on which preheating and annealing are necessary is handled in the shop, the portable equipment being used on outside jobs that do not require special handling of this kind, or where it is simpler to erect a temporary preheating furnace of loose bricks than to dismantle and transport the part or parts to the shop.

Applications

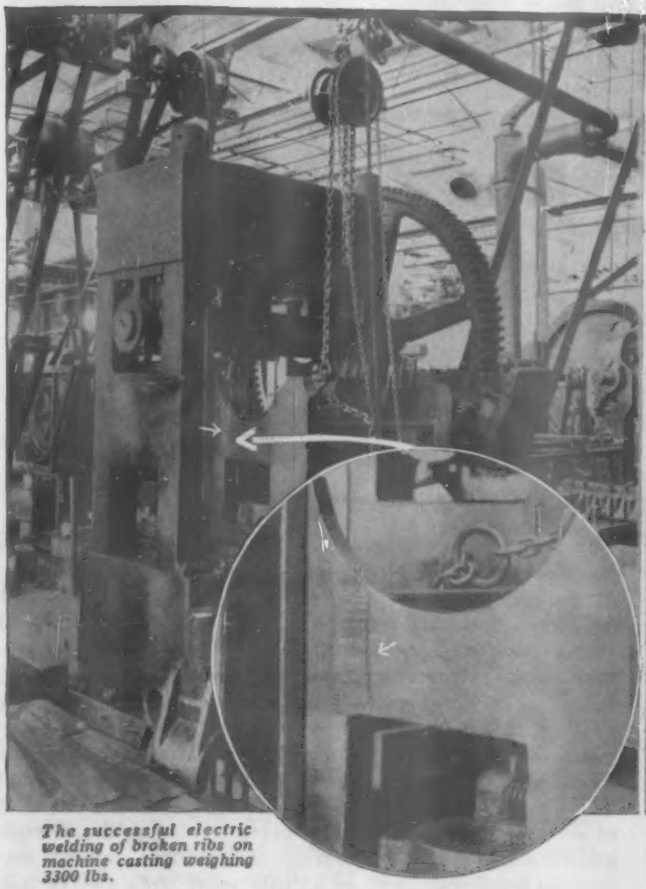
An idea of the character and variety of oxy-acetylene welding and cutting done at Anaconda may be had by briefly reviewing some of the work performed in the course of ordinary routine, as follows:

Building up worn spots on clam-shell buckets, pulleys, rollers, gears, keyways on shafts, motor armatures, shafting, worn and stripped threads, wind-boxes, on converters, tuyeres in blast furnaces, water-jackets, frogs, rails, switch points, and in short almost any worn or burned out plate or cast iron part in machinery or other metal equipment.

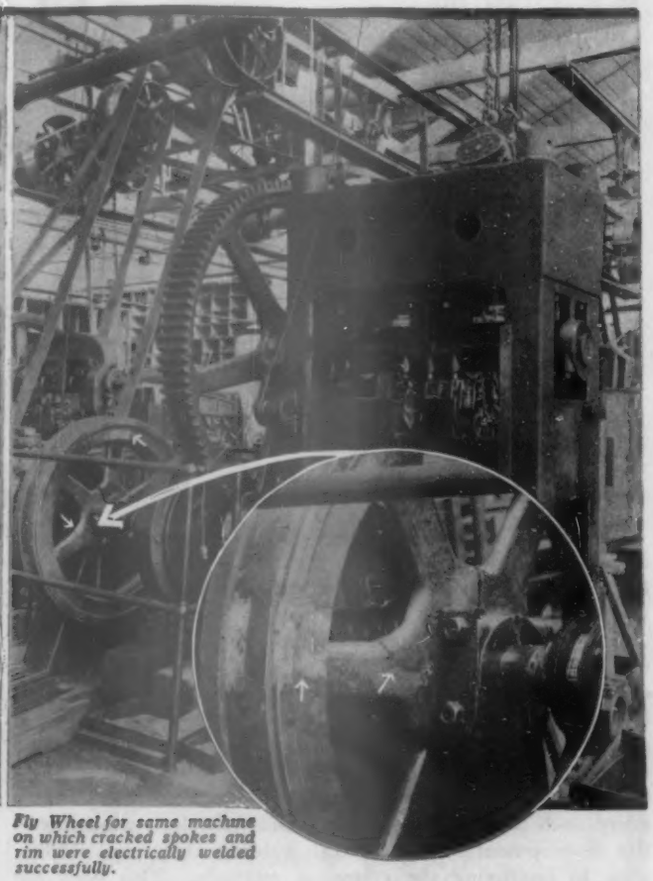
Welding of coal-dust cycine collectors, coal-dust hoppers, conveyors and piping, reverberatory water-cooled slag-launders calcine and flue-dust hoppers, dust and concentrate cars, matte and slag ladles, converter wind-boxes, tuyeres and roaster-gearing floors, hoppers, calcine-cars, center-shafts, arms, cars, shafting, air compressor parts, intake and exhaust piping of air-receivers and coolers (42 ounces to 900 lbs. pressure per square inch), water and steam piping in all shapes (Y's, T's, L's and X's, manifolds, etc.), electric motor and generator housings, end-bells, bed-plates and motor gears, starting boxes and transformers, oil tanks and pipe, high amperage copper conductors and connections, machine tool parts, roll shells, locomotice receivers, levers, links, filing rivet and bolt holes, etc., etc.

Welding and Brazing of (copper) pipes, tanks and bars; (brass) pipes, tanks, bars and bearings; (bronze) bearings, levers, bushings, shafting and pipes; (aluminum) bars, pipe and plates.

Electric welding saved this machine



The successful electric welding of broken ribs on machine casting weighing 3300 lbs.



Fly Wheel for same machine on which cracked spokes and rim were electrically welded successfully.

The following extract is from a letter to us by Enoch Ohnstrand, Chief Engineer, LIBRARY BUREAU, Ilion, N. Y.

"We figure that this repair on this machine showed a sufficient saving to pay for the installation of our electric equipment, as the machine which was broken down was a special machine made years ago for this Company, and even if it had been an up-to-date machine, we could not have purchased this part for anywhere near the price of the electric welder which we purchased from you and which we used for doing this work. I am pleased to advise you that we got splendid results from the job and in a very short time. The repairs, so far as welding was concerned, were made in about three hours actual time."

The line of G-E Electric Arc Welders includes types of stationary and portable sets for hand welding—and automatic and semi-automatic machines. G-E Specialists are at your service to select the equipment essential in electric welding processes for repairs, production or salvage in your plant.

General Electric Company

General Office Schenectady, N.Y.

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43B-711

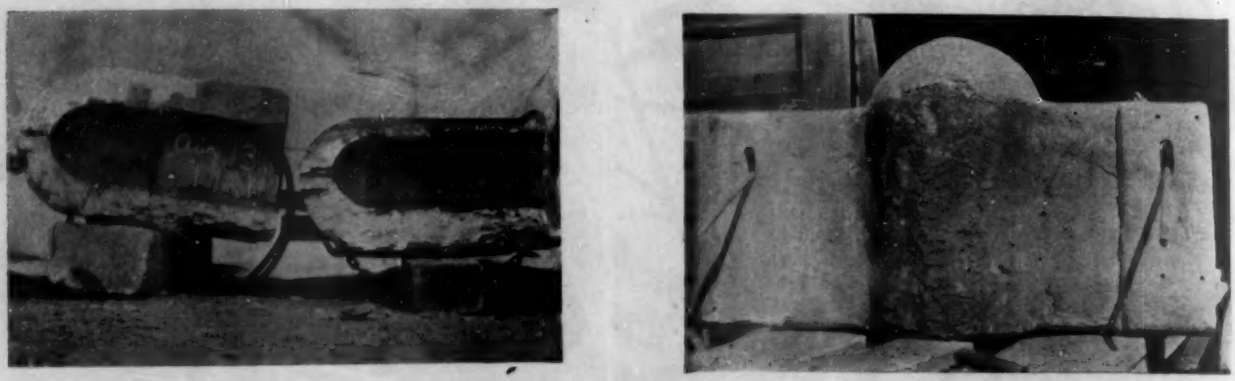
Heating of links on fly-wheels, shafts to straighten, gears to remove from shafting, etc.

Cutting of plates, angles, I-beams, channels, rails, alteration in structural steel on erection or dismantling jobs in the field, rivet and bolt holes and various other work that was formerly done with hacksaws, chisels and hammers.

Cast Iron Cutting—Cutting of cast iron sections for demolition, plant changes and beveling for welding.

Tapping of blast and reverberatory furnaces.

Cleaning out tuyeres and wind boxes of converters.



A 300-Lb. Hydraulic Car Axle Press Before and After Being Welded.

In view of the numerous oxy-acetylene applications noted above, it is indeed surprising that there are yet some very large mines which make relatively small use of oxy-acetylene. Obviously, this is not because there is not abundant opportunity to do so, but because the possibilities of the process are not sufficiently understood and appreciated by the operating executives. For every large mine that is not getting what it could and should out of oxy-acetylene there are dozens of small ones in the same class, but there are also many small mines that are getting very much more out of the process than are inadequately equipped large mines. In nearly every such instance, it will be found that the reason lies in the development of the central welding shop idea, with a view to improving the efficiency methods. This does not mean the abandonment of portable equipment; it simply makes portable equipment an important supplementary arm for doing work that cannot be properly handled in the central shop with stationary equipment.

Recently a special inquiry was made to ascertain how general is the use of oxy-acetylene in the mining industry and to obtain data covering operations in mine use. A questionnaire sent to mining companies in various parts of the United States, Mexico and Canada elicited some very interesting replies. All but one or two declared that they used the process. Some of them had used it for many years. Some stated that they used the process only in a limited way for repairs on small castings which were subjected to little or no strain, and for emergency cutting. Almost invariably these felt that the process was unsuited to heavy welding. In some instances they stated that they had tried to do heavy work and had not met with success. Diametrically opposed to these discouraging reports, were others expressing enthusiasm concerning the wide range of uses for both welding and cutting and regarding successful handling of heavy welding as ordinary routine involving no special difficulties.

The difference in these reports was not due entirely to a difference in facilities, of course, but it was largely so. As a rule the central welding shop at mine and mill is a growth of experience—a slow growth in which prejudice must gradually be worn down to make room for earned confidence. But with a broader study of the possibilities of welding and cutting applications as they are being employed successfully in actively operating mines and mills, it is possible to profit by the experience of others and the process of extension need not now be as slow as in years gone by.

When a mine superintendent once realizes what the real successful users of oxy-acetylene are getting out of its advanced development, so that he can make a reasonable and intelligent appeal to his superiors, he will find that there is not a wide-awake, progressive executive who will deny him the relatively small investment necessary to place him in a position to accomplish similar work.

In the opening paragraph of this article, it was stated that the Anaconda Copper Company was one of the first users of the oxy-acetylene process in the mining industry. The company's first equipment was installed as early as 1909. In 1912 a complete Linde outfit was purchased and in the years 1913 and 1914 some very extensive work, measured even in the terms of big operations today, was done by the company. Perhaps the most notable job was the welding of the plate steel roof of the company's main flue at its Anaconda plant. There were 1,711 steel sheets or strips, each 120 ft. in length by 3½ ft. in width, laid end on end and side by side to a width of six sheets, all of the seams being welded as the assembly progressed. When completed, the welding totaled more than 64,000 linear feet, or a little more than twelve miles of welded seams. About eleven months' actual working time was required on this job, during which period an average of seven to eight men per day were kept busy cutting out the old roof and welding up the new plates. It is estimated that 50,000 lbs. of carbide, 8,500 lbs. of ¼-in. Norway iron rods and 400,000 cu. ft. of oxygen were used in the work. Another interesting job of this early day was the welding of 28,400 linear feet of seams in the fabrication of ten launders and feed distributors for a 20-deck round table.

It would require a library to catalog and describe all of the oxy-acetylene welding and cutting that has been done by the Anaconda Company in the past dozen years. The process has been used in maintenance of plant, in demolition of old construction, in the erection of new structures and in the fabrication of various kinds of equipment from material that would otherwise have been worthless excepting as scrap. And extensive as have been the uses of the process at this great plant, a review of applications in other parts of the country reveals dozens of operations differing from the ones enumerated, but, in almost every instance, operations that could profitably be employed at Anaconda and other producing mines and operating smelters or reduction works, wherever they may be located.

Of course the Anaconda Company have made use of the recently developed cast iron cutting. Details of this work will not be given here, but it should be noted that oxy-acetylene cutting of cast iron is receiving attention in the mining industry and is being found as serviceable there as in other industrial fields.—*Oxy-Acetylene Tips.*

A Short Story Prize Contest for Welders

The Welding Engineer wants good welding stories; stories which will be helpful to the other fellow. In order to be sure of getting the best stories which welders can contribute from their experience, we are putting them on a competitive basis, and are offering three prizes for the three best stories submitted each month, as follows:

1st Prize: Class C Membership in American Welding Society.

2nd Prize: Class D Membership in American Welding Society.

3rd Prize: Copy of Welding Encyclopedia bound in Leather, Stamped with Owner's Name.

CONDITIONS

There is no restriction as to the length of this story, or the time in which the work is done. The assignment of prizes will be based on the value of the story as a whole to the readers of The Welding Engineer. Manuscript does not have to be typewritten, and it will not be judged upon its literary merits. If sketches are necessary to illustrate any features of the work, you need not submit finished drawings. Pencil sketches will serve the purpose just as well. One point to be kept in mind is that the story ***should be complete enough to enable another welder to do the same job after reading it.*** There is no restriction regarding the nature of the work described. It may be either production work or repair work. It may be oxy-acetylene welding, electric arc welding or thermit welding. The value of the story may consist entirely of a description of the method of preheating in the case of a repair job, or in the construction of a jig in the case of production work. The purpose of the contest is to bring out practical working instructions which will enable the other fellow to do a particularly difficult piece of work.

In case manuscripts are received which are considered good information for our readers, but which are not quite so good as the stories which are winners in the prize contest, they may be printed in The Welding Engineer, in which case the story will be paid for at our regular rates.

Mail your best welding story to

THE WELDING ENGINEER

608 South Dearborn Street CHICAGO, ILLINOIS

NOTICE: Awards of stories received in November will be published in the January, 1923, issue of The Welding Engineer.

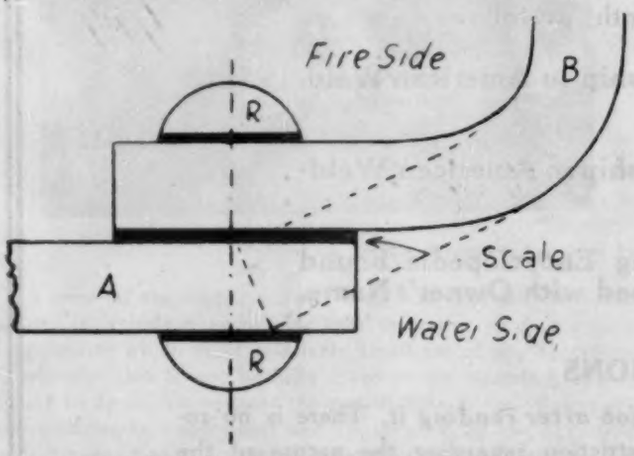
A BOILER WELDING STUNT

An Experience Which Shows That Welding Failures Are Not Always Due to the Welding Process Itself

Fort Worth, Texas,
Sunday.

Salutations Ed:—

Do you remember that boiler job you had down at Miller's, two years ago when I was home? Perhaps you would rather forget it. But I distinctly recall going down with you three times to see you fix it but each time you got through with it the boiler was just as bad off as before, or, if you'll take no offense, Ed, perhaps just a little worse off. Each time we went down, you swore on a stack of bibles

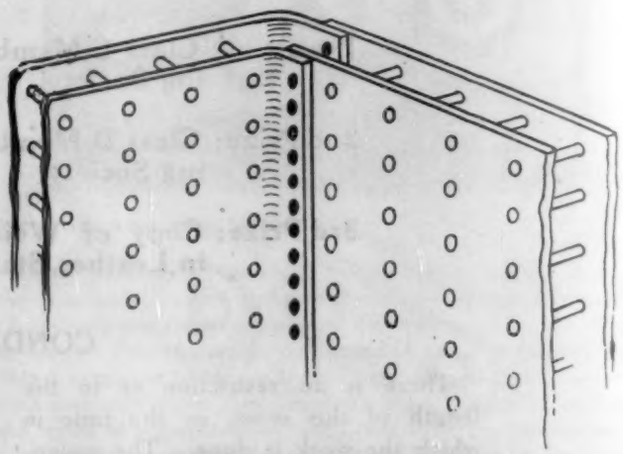


How Scale Forms Between the Lapped Plates.

that you were going to make that weld hold but every time we left it and they fired up, it was the same sad story; she'd open up again. Sort of a cheery way to open a letter to you isn't it, Ed, but to tell the truth about it, I never was quite satisfied with your alibi on that job. You claimed that the plate was all eaten away and was beyond saving with the welding torch. So ever since I've been on sort of a still hunt to get you the answer to your problem. I didn't say anything to you about it for fear I might not get it but at last, I found the solution for you. There is no "ifs", "buts" or "ands" about it, I've got the real dope for you this time and "By Jiminy" if this stunt doesn't bring two or three hundred extra dollars into your pocket in the next sixty days, I'll say you're not the Ed I always thought you were.

As I just mentioned, I've been on the hunt for some real clever steel welder, who was thoroughly acquainted with boiler work, to talk over that failure of your's with, ever since it happened. I never came in contact with such a combination that really appealed to me, until I met this fellow in Fort Worth. It was quite by accident, too, but it seems strange in a way, to find the answer to your problem away down here in Texas, doesn't it? This is how it started. I walked into a place where a welding demonstration was evidently in progress. Everybody in the shop was gathered together watching a weld being made on a boiler. Naturally my curiosity was aroused so I wormed my way up as close as I could to the operator. After watching him a few minutes I stood there sort of spell-bound, like the rest of his audience. Ed, there was a master if there ever was one that handled a welding torch. I doubt whether anybody else present appreciated the true fineness of that weld, as I did. That fellow could make his metal do anything under the sun. He could make it flow up or flow down to his right or to his left. I never saw the like of it anywhere. I've seen hundreds and hundreds of welders, Ed, but my hat was off to this chap. Why that flame of his was just as soft as the coo of a humming bird. The metal followed the flame anywhere he lead it and the beautiful part of the whole performance, to my mind, was the fact that there wasn't a single spark to be seen. Honestly Ed, it certainly was a treat and Oh! how I did wish that you were there.

As you might suppose, I didn't lose much time in getting acquainted with this welder. For the most part he had spent much of his time, after he come to this country, in rail-



The Seam Which Gives So Much Trouble.

road shops and was very well posted on the equipment used in that line. When welding was brought out, it appealed to him so he sort of specialized in its application to railroad work. That's evidently the reason he became so well versed in the welding of steel. When the subject of boilers was brought up, it was plain to see that he knew them from A to Z. This was specially true of locomotive boilers. Considering everything, I figured that he was the very man to give me the right dope on jobs like you were up against at Miller's. Say Ed, I was mighty glad I did too, for he proved to be one of those type who glory in figuring out anything that the other fellow has failed in. Fact is, you could almost liken it to a fiendish delight. Here's his explanation:—

"As you would have me understand," he started "your friend was called upon to weld some checks in a fire-box." These were located on a riveted seam and ran from the rivet hole to the edge of the sheet. It so happens that I am very well acquainted with this kind of a job and it will not take me very long to explain it to you. You told me that your friend is a good welder and has been doing it for a number of years. You also tell me that after welding up the cracks that they hold cold water very well but after a day or two of firing, that the seam leaks worse than ever. Now let me ask you a question. Did the thought strike you or your friend that the welding was perfectly alright but that the cracks were due to another cause entirely? That's about the size of it and if you follow me you'll see the reason why.

"A number of years ago I was confronted with the same kind of a job myself," he continued. "I went about it the same way as your friend, by simply welding up the crack and also welding around the rivet head, for naturally it would be loose otherwise, and I'd not have any way to draw the rivet

up. After the weld was made and the boiler given the cold water test, there was a leak along the edge of the sheet, due to the contraction of the metal after being heated, but the edge was easy to caulk and there wasn't the sign of a leak any place. However, after the engine had made one run, the seam was worse than ever. What was the trouble? I asked myself. I had made a deep study of welding steel and felt that it simply couldn't be my weld for failures occurred very, very seldom and as a rule, through no fault of mine. But here was the job back in the shop and it was up to me to fix it. Something had to be done, so again I tackled it. This time I took extra pains to make a perfect weld and it turned out fine. The seam was again caulked and the engine sent out on its run. Imagine how I felt two days later to be called on the carpet and learn that the engine was again coming to the shop with the same trouble. I felt sick and wanted to quit my job but the superintendent told me to go home that night and see if I couldn't figure out just what the real trouble was. He felt like I did that it was not the fault of my weld but undoubtedly there was something causing the trouble; so I went home with a firm resolution to stay up all night if necessary, to figure out a way to do that job and make it hold.

"I concentrated on my problem that evening and worked it all out. It's strange how I can take things home with me and figure them out clearly, when the thing seems hopeless down on the job. How did I figure this one out? I'll tell you right away. First of all, I asked myself this question:—Why did the crack occur in the first place? If I could work this out then I would have to reason the thing out in this manner:—Did I remove that cause in welding? It did not take me long to satisfy myself that I had located the cause of the checking. Heat was the cause. These checks were always on the fire side of the seam. Apparently the water did not keep this side of the lap cool. Why should this be? There could be but one answer. The scale in between the two plates was acting as an insulation. This sounded logical to me and I became thoroughly convinced in my own mind, that it really was the cause of the trouble.

"If the scale acted as an insulation and prevented the water from keeping the fire-side cool, did I remove this cause by welding? The answer was very evident; I had not. What was more natural than for it to open up again?

"So far so good," he continued. "With the cause known, half of my problem was solved, but that alone would not fix the boiler. The task on my hands was a big one. If the scale were the foundation of my trouble, it would be useless to attempt any more welding without taking that scale into consideration. It was evident that the scale had to be removed or the weld could never be expected to hold. I could not very well take the seam apart to clean the scale off, I said to myself. But how else could it be done? Truly I was up against a stiff one this time.

"There is one thing about me; I never give up, so I kept right on thinking this job out. I got out some paper and pencil and drew the whole thing out so as to have it in front of me. After trying it this way and that way (on the paper) until three-thirty in the morning, I at last decided upon a method which I calculated would work out better than anything else. Having made that decision, I well remember how I threw myself on the bed, clothes and all, and grabbed off a couple of hours sleep. The next morning I marched down to the boiler shop and with a little assistance, I finished up the job by the middle of the afternoon. Did she stand up? You bet your sweet life she stood up; how could she help it?

"Now, of course, you want to know how it was done. If we can find a piece of scrap paper to draw on, I think I can explain it a little more clearly and then you can send the sketch to your friend with a few notes if you wish." He found the paper and dug up a stub of a pencil. Shortly the enclosed drawing was produced. "This view," he explained "is sort of sectional. The sheets (A) and (B) are held together by the rivet (R). Now as you must remember, the scale has accumulated between the two sheets and has formed what the trade calls a 'hot shot.' The scale had to be entirely removed so here's how I went about it. First I took my cutting torch and made a cut right through the center line of the rivets. This naturally cut through both plates and then the balance was very easy. By throwing a heat on the angle in sheet (B) and hammering it outward, it soon reached a position which I show here by the dotted lines. From there on, it was strictly a case of straight welding. It might be a little mean for welders who weren't accustomed to boiler welding for all welding has to be done in the fire box. There was also a gap between the two plates and every four inches there was a rivet hole to be filled up. To an experienced man, this weld presents no trick at all. I see you have a question in your mind. Perhaps I can guess what you're thinking of. You want to know how the contraction is taken care of, don't you? I'll answer that right this minute. You see that bend in plate (B)? That's the answer. In making the weld so close to the corner, the contraction is all provided for and should cause no concern."

"You are quite right about me having a question, but that wasn't it you mentioned," I said. "I was just wondering what became of the short ends of (A) and (B) which are cut off; also the rivets. I can see how the end of (B) is removed but how do you get the surplus end of (A) out?"

"We don't" he answered. "Why take it out? It don't hurt anything, so we just let it drop off on the inside and stay there. Now picture, if you will, the finished job. When (A) and (B) have their edges butted together and are welded in that position, could a more ideal condition be conceived? One plate; one thickness all the way through. The water has ample opportunity to act on all parts and 'Hot-Shots' are a thing of the past.

"It may interest you to learn too, that shortly after figuring out this stunt the superintendent raised me to be a foreman of all welders on the system, so you can't blame me for remembering about that particular job after all the circumstances are considered."

That, Ed, was about all he had to say regarding your Miller boiler but I take it that you ought to "sabe" from the sketch and what I've written. Here's hoping that it makes you a million.

Same as ever,

SHEP.

Postscript—Guess I'm slipping a little, Ed. I forgot to tell you that my friend gave me a five finger set of rules for welders tackling boiler work. I wasn't going to mention them because I thought surely you would know them anyway but just now I figured it would do no harm, perhaps one of them may be new.

Rules for Operators Doing Boiler Welding

1st. Get posted on reglations covering Boiler Welding.

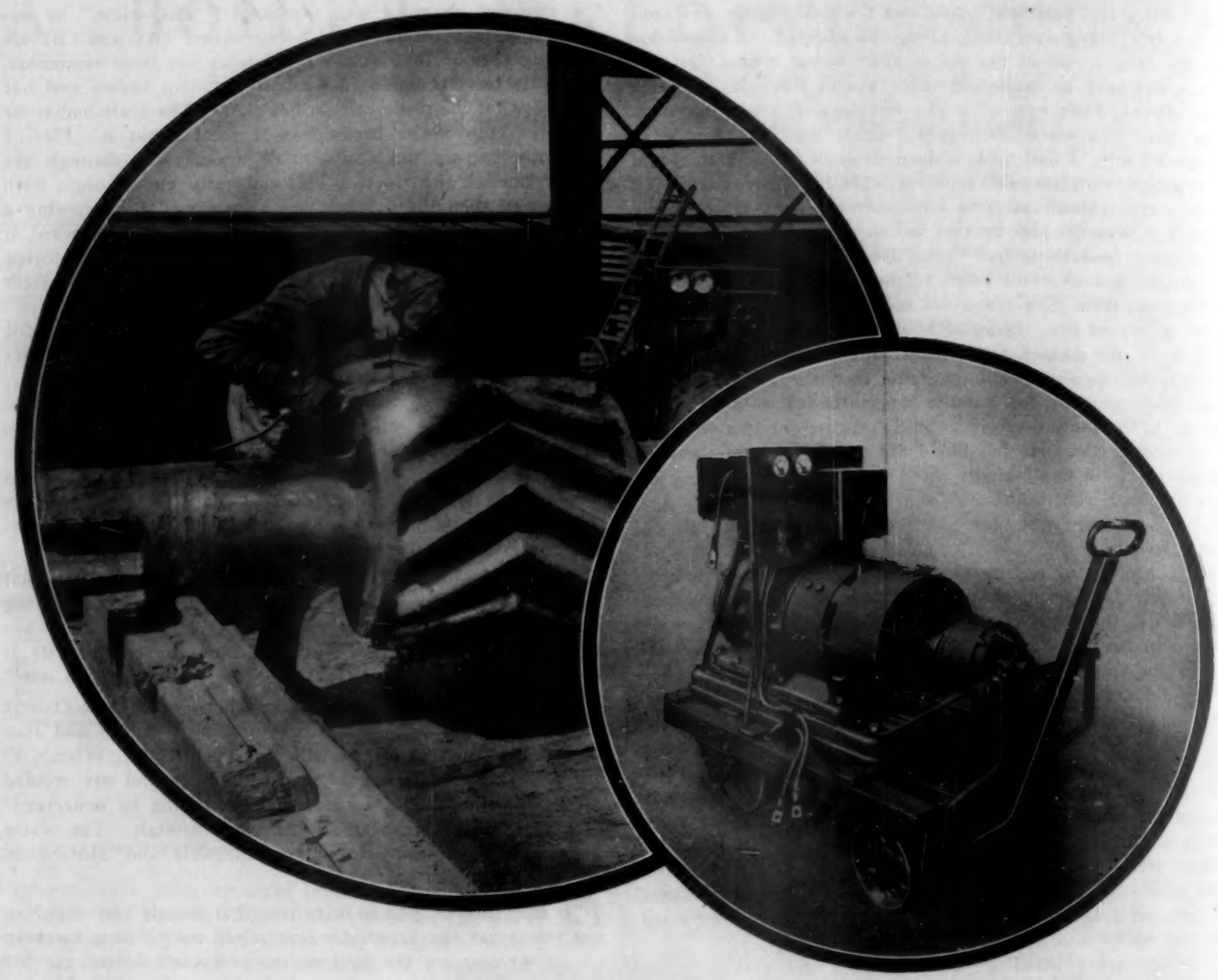
2nd. Learn adjustment of flame most suitable for steel welding. Must be soft, with no evidence of hissing, for good results.

3rd. Inexperienced should practice vertical and horizontal welding. (Horizontal most difficult.) Pay particular attention to size of flame and filler-rod. Note results of various sizes.

4th. When working inside fire box, always have helper outside to handle gas tank pressures.

5th. Always wear Goggles. Flying hot scale very dangerous.

SHEP.



Westinghouse Equipments

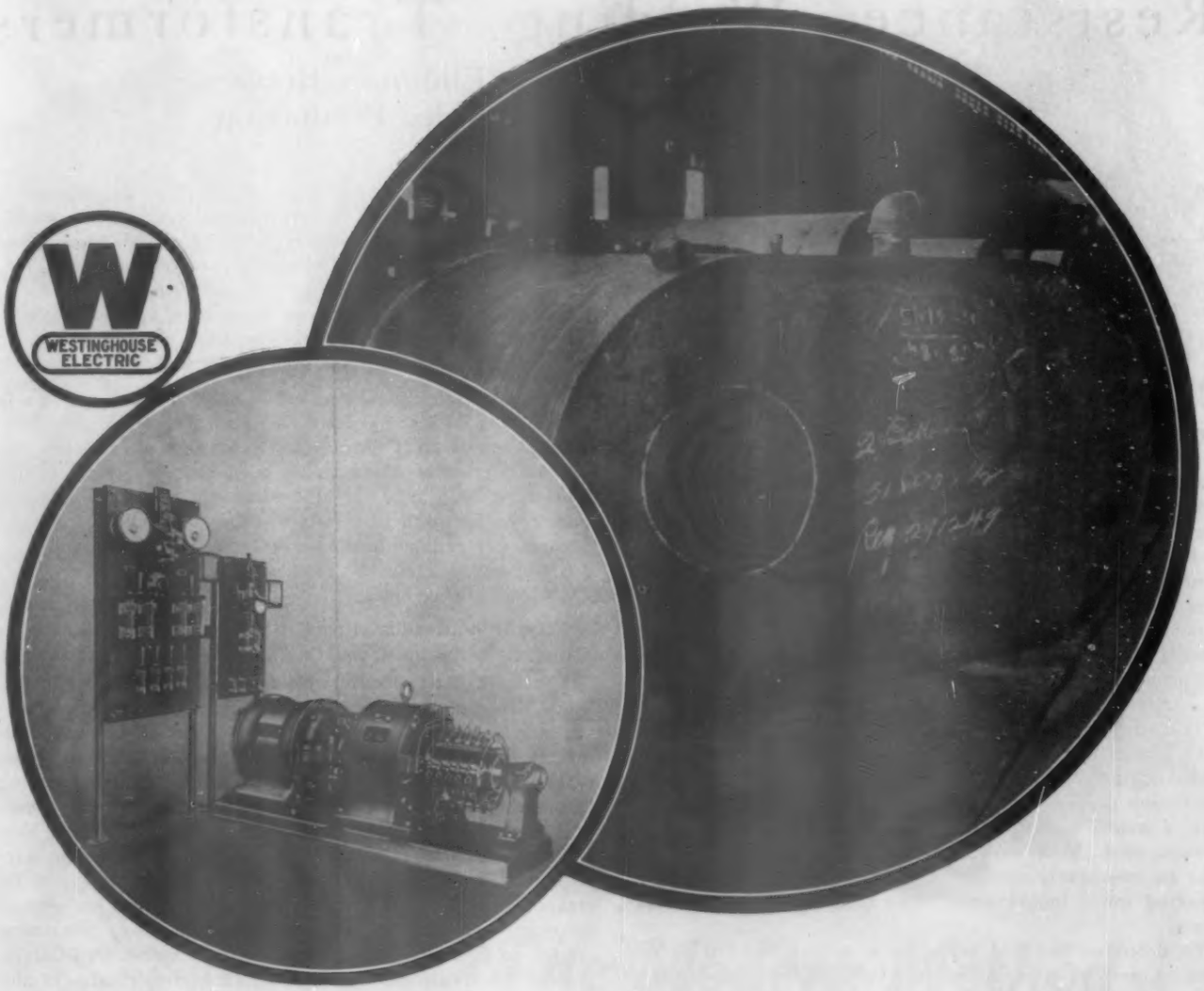
Of all the factors which enter into the making of a perfect weld, arc steadiness and arc control are of prime importance.

The idea back of the Westinghouse Equipment was to build a machine which would assist the operator in obtaining good welds consistently, and yet have a rugged simple design and construction.

The first thing done was to simplify the design as much as possible in order to secure an easy running, rugged machine to give continuous operation for steady welding work.

Second, a control system was worked out by Westinghouse Engineers, a simple, strong controller, giving the op-

Westinghouse



Assist the Operator

erator any current he may desire at the arc, or a single, steady current for a full day's work from a single rheostat. This flexibility is one of the distinct advantages of Westinghouse Welding Equipments where the Welding work is variable.

And lastly, the Westinghouse Equipments were perfected in all sizes from the popular 175 Ampere portable equipment to the heavy multiple operator equipments which have made Arc Welding such an important factor in modern production.

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Resistance Welding Transformers

How Modern Design Tends to Eliminate Breakdowns, Low Efficiency and Retarded Production

By J. B. Borgadt†

AN electric welder is in its essentials an electrical apparatus with the characteristics, faults and requirements of care peculiar to all electrical machinery.

An electric welder is usually used by unskilled men and treated, sometimes very roughly too, as rude mechanical machinery.

The electrical parts of an electric welder are:

(1) The transformer, a step down transformer which, though electromagnetic action, brings the higher line voltage of low amperage down to the higher amperage but low voltage required at the welding jaws.

(2) The control which consists of the switch, either manual or automatic, a pivot switch or other means for regulating the primary voltage. Sometimes this is called, although not correctly, current regulator.

The most vital part is, however, the transformer, and varied problems are encountered in the operation, design, and manufacture of this.

Excessive heating causes frequent breakdown, low efficiency, and retards production. The cause may be one, several or all of the following:

(1) *Improper Rating.*

Transformer too small, on account of arbitrary rating. As yet no rules have been established for rating electric welding transformers. At present they are rated very much by rule-of-the-thumb methods. The writer found once, upon investigation, a welder name plate rated 250 K. V. A. capable of delivering 92 K. V. A. without dangerous heating. It is evident that an improperly rated transformer cannot carry the load expected for a longer time. The result is ultimate breakdown.

To detemine the real rating of a welder proceed as follows: Connect the secondary to a load, such as a rheostat of heavy iron bars, of sufficient size to bring the primary current to its full load value. Effort should be made to have everything as it is during actual working conditions or as near as possible. The transformer should carry this load continually for one hour and the temperature rise above the room temperature should not, at any time, or any point, exceed 50° C. As a rule, the name plate rating is given in K. V. A.

In accordance with the standards of American Institute of Electrical Engineers, K. V. A. is the unit of *output* of any alternating current apparatus.

One K. V. A. equals 1,000 volt amp. Therefore, to find the rated primary current, the factors of efficiency and power factor must be taken into consideration. As these vary with different makes and sizes it is very difficult to determine the primary current. The writer has, however, found that approximately 60-75% efficiency on average standard make and as high as 95% on later designs is about correct. Although not backed by any engineering authority, it is believed to be better than the present arbitrary name plate rating.

(2) *Design of Primary.*

The conductors, although of sufficient size, may not utilize their entire current capacity. Flat double cotton covered wire is mostly used, several wires in parallel wound one above the other. With such an arrangement all wires will not carry their proportional share of the current. The one nearest to the core often carries as much as twice its share. Therefore, although the total area of all wires may be sufficient to carry the current, excessive heating will occur on account of unequal distribution.

The outer wires being longer and farther away from the core will carry less current and the bad conditions are exaggerated through s. c. circulating currents. These are currents which are set up and flow within the coil, from the inner wire through the outer and back. This current is dissipated in form of heat and the loss may be as high as 5-10% of total losses. The insulation between parallel connected wires is useless only increasing bulk and cost of coil.

The most efficient coil, easiest to cool, giving equal current distribution with consequent even temperature rise, is wound of bare copper strip with insulation between each layer, The best insulation is found to be oiled linen or empire cloth. This type of primary is best wound in several small compact coils for each transformer. Easy and cheap to manufacture, it facilitates bracing and arranging of taps and various connections. Buckling is also prevented.

(3) *Design of Secondary.*

Very little attention is paid to this part, a chunk of copper arranged in the most convenient way serving as secondary.

The load of an electric welding transformer is very peculiar. Being of short duration and intermittent, it fluctuates violently. The cold resistance of a weld is only approximately 1/10 of the hot resistance. The speed of welding depends upon the current the transformer is capable of forcing through the weld in a given time. When the current fluctuates from maximum to 1/10 of this value, it is evident that some provision must be made to even out these violent fluctuations. To soften the shock of the first contact and increase the current during the later welding period, an internal automatic reactance is required. Many welding transformers fail to do this. The internal reactance being fixed fails to protect the transformer when exposed to sudden shocks and does not increase the current during the later welding period. The transformer, instead of acting as a stiff yet flexible spring, is absolutely rigid and breaks down during overload.

By laminating the secondary, as in recent development, and providing an air core of sufficient size between each lamination, an internal automatic reactance is provided which acts only during overload and the first moments of contact when the weld is cold and the current therefore unusually high, sometimes high enough to break down the transformer.

During the latter part of the welding period the reactance is automatically disengaged and the transformer forces the full current through the weld, increasing the production considerably. An increase as high as 23% has been obtained in tests. The electrical equipment such as generators and power transformers are protected from sudden shocks. A smaller investment in machinery is necessary. The power station must provide equipment for the peak load or nearly so. So by having a low peak load and high average load a larger production is obtained from the same power equipment. The power factor is also improved. As high as 73% has been obtained.

If the secondary is made of solid cast copper the full carrying capacity is not utilized as cast copper has a current capacity of only 60% of commercial pure copper. In larger transformers the s. c. skin effect is an added advantage.

In any conductor carrying 60 cycles, a. c. the current does not penetrate deeper than .308 of an inch. All copper beneath this surface stratum is useless copper. This law holds good for cast as well as flexible copper bands bunched together. *The current density is, therefore, not equal all through,*

† *President, U. S. Electric Welder Co.*

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Thermalene Gas *for Cutting & Welding*

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the surface nearest the coil or core to a depth of about ¼" carrying most of the current decreasing about 50% every ¼-inch measured radially to the core, from which it follows that in a secondary ¾" thick the current density is about twice as high on the surface nearest to the core as on the outer surface.

A laminated secondary provides equal current distribution as well as three times the usual cooling surface together with facilities for support which give excellent results.

The importance of having the secondary properly braced or supported is very often overlooked. The electromagnetic thrust which is set up during full load sometimes reaches a high value. This action tends to bring all the coils to occupy the same room which is of course impossible. In a 15 K. V. A. transformer this twisting and bending force may reach as high as 40 foot lbs., equal to a good hammer blow. The figure given is only approximate as conditions are almost impossible to calculate with accuracy.

(4) *Loose Core.*

Besides causing a disagreeable humming noise, always a sign of a loose core, it increases the magnetizing current beyond reason.

The magnetizing current is the current required to magnetize the core with no load in the secondary. It is an unavoidable loss and should be very low, not over 5-6% of full load current.

Loose laminations caused by lack of proper clamps or support increase the magnetic resistance and therefore the magnetizing current.

The writer found one case where it was 43.5% full load current.

A silent, compact, well stacked and securely clamped core means low magnetizing current and consequently high efficiency.

Summary

The requirement of good efficient welding transformers can be summed up as follows:

1. *Strong Electrical Construction.*

To withstand the number of electrical shocks it is exposed to a thousand times a day, the primary is closed. A shock may be twice as severe if the line voltage happens to be of peaked wave form and the switch closed at the very top of the wave.

2. *Strong Mechanical Construction.*

To withstand the electromagnetic thrust exerted on primary and secondary so that all twisting, bending and motion of these is prevented as well as to prevent humming of core and loose secondary, strong mechanical construction is necessary.

3. *Good Regulation.*

With internal automatic reactance to prevent violent fluctuations of current and produce a nearly even load curve with high power factor during the entire weld, the regulation is improved.

4. *High Efficiency.*

Lately welders have reached a capacity of 250 K. V. A. and 5-10% better efficiency means a considerable saving in a year.

5. *Good Cooling.*

Good cooling should be provided through ducts between primary coils and in secondary and core.

6. *Low Price.*

The transformer should be so designed as to utilize every ounce of copper and insulation with minimum work expended.

GENERAL ELECTRIC COMPANY ANNOUNCES "CHARLES A. COFFIN FOUNDATION"

On May 16, 1922, Mr. Charles A. Coffin, in his 78th year, retired from the active leadership of the General Electric Company.

Mr. Coffin has beeen identified with the development of the electrical industry since 1882. He was the founder and creator of the General Electric Company, of which he has been the inspiration and leader for thirty years.

As an expression of appreciation of Mr. Coffin's great work not only for the General Electric Company but also for the entire electrical industry, and with the desire to make this appreciation enduring and constructive, as Mr. Coffin's life and work have been, the Board of Directors of the General Electric Company created on his retirement the "Charles A. Coffin Foundation."

By action of its Board of Directors, the General Electric Company has set aside a fund of $400,000 to be known as the "Charles A. Coffin Foundation," the income from which, amounting to approximately $20,000 per year, will be available for encouraging and rewarding service in the electrical field by giving prizes to its employes, recognition to lighting, power and railway companies for improvement in services to the public and fellowships to graduate students and funds for research work at technical schools and colleges.

EGYPTIAN STUDENTS TO STUDY WELDING HERE

Considerable interest has been occasioned by the arrival in this country, this month, of six officials of the Egyptian Government, who have been sent here to study the automotive industry. The general opinion of Egypt as a country still living in the past, evidently revision, as this example of progressiveness indicates.

The men sent here are accredited representatives of the Ministry of Transport and Communication. They are instructed to spend three years in this country, the entire expense being paid by the Egyptian Government. The United States Department of Commerce, of which Herbert Hoover is head, is co-operating with the Egyptian Government in securing the proper placing of the men during their stay here.

Gordon Lee, Chief of the Automotive Division of the Bureau, brought them to Detroit, the heart of the automotive industry, and is arranging to have them spend the greater part of their three years there, on account of the exceptional advantages which Detroit offers, to study this great business.

These Students are Taking Three Years' Work in America.

The first year will be spent at the Michigan State Automobile School, where courses in automobile and tractor mechanics, advanced automotive electricity, oxy-acetylene welding, tire repairing, battery repairing, and machine shop work, will be taken.

The six Egyptian students, whose names are: Fawzy Barsoum, Jacob Farag Girgis, Mustapha Ibrahim, Mohammed Mustapha Hetta, Mohammed Hassan Serour, and Ahmed Hamza, are all college graduates, having attended institutions in Egypt which are said to rank with European and American colleges.

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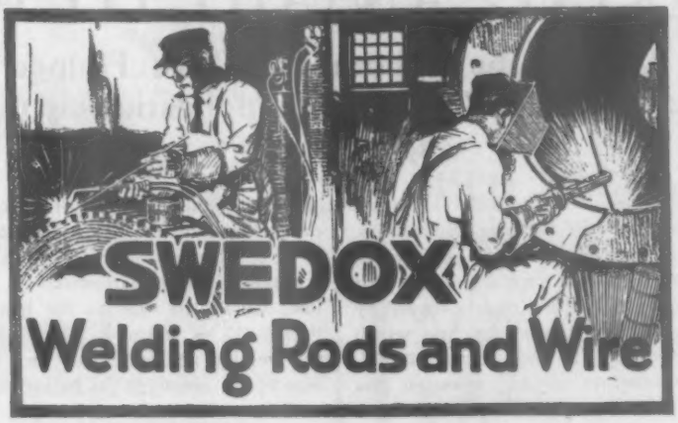

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ENGINEERING AN AID TO WELDING*

How the Men in the Laboratory Have Helped the Oxy-Acetylene Welder to Perfect the Applications of the Process

By C. E. Ziesel†

IT was the engineer, and the engineer only, who developed the oxy-acetylene process, its sound practices and its applications, so that it was possible for the industry to regain its lost ground, to live down and profit by its mistakes and earn a prestige that places it on a high plane industrially, a position clearly earned by service. It was due to the engineer that the welded line, which at first could not hold tight even when lying inert in the ground, inert excepting for ever restless contraction and expansion, became perfected to a point where tens of thousands of welds might be completed almost without a defect of any kind and with none that could not be readily corrected with a punch and hammer and without rewelding—perfected to a point where the line might be left on the surface exposed to the severest weather and temperature changes, holding like a wire cable, even when left suspended in mid-air by washouts for spaces covering hundreds of feet at a stretch—perfected to a point where it would hold against swirling currents at river crossings and stand the gaff of the fatigue and strains which soon destroy screwed and coupled lines.

The engineer's job was not alone to find a way to make a weld which would be sound, to make a joint which would hold against the strains of service. He had to do this much and more. He had to find a way to test his work which would prove it good or show it defective. Before it was practicable to adopt welding in the place of screwed and coupled joints there were many factors to check. The advantages and possibility of making cut-ins, laterals, and special fittings were a consideration. Economy and speed of fabrication were also points in favor of welding, but the question as to whether the weld would hold had to be definitely and satisfactorily settled before a pipe line company would feel secure in placing a line in service. That was work for the engineer, the oxy-acetylene engineer and the pipe line engineer. The pipe line engineer was hard to convince. The oxy-acetylene engineer had first to do his work and do it in a way that would appeal to the pipe line engineer. He had to make good and the welded pipe line had to make good. And when both had made good, pipe line engineers who were progressive manifested keen interest in checking up on the process. The result has been more pipe line welding in the past year than in the preceding ten years.

There is a tendency on the part of some persons to feel that extravagant claims are being made for welding, that even application engineers are prone to over-enthusiasm. I think this is essentially a misconception. No doubt there is an inexperienced welder now and then who may make an extravagant claim for the process, even as nearly all welders made extravagant claims some years ago. In such cases the reason is plainly ignorance. The engineer, on the other hand, is very cautious. I well remember some two or three years ago, when a certain firm of welders in one of our midwestern states fabricated two welded steam lines, one for a union railway station and one for a large tire manufacturing plant. At the time these lines were conducted a number of photographs were made showing portions of the line. These photographs were supplemented by detailed data concerning the job, the manner in which the welding was handled and particularly the severe tests to which the joints were put before being passed by the contractor. This mass of material was sent to the welding engineer of one of the large oxy-acetylene groups of companies and was eagerly sought by various persons in connection with publicity articles. The consulting engineer in this case refused permission to publish the matter. His objection was that the industry was not yet ready to weld steam lines. It was true that these lines apparently were all that could be desired but, as the engineer put it, steam has another element to deal with besides pressure. It scalds, it kills. And the industry must under no circumstances encourage the welding of steam lines until such time as the industry itself provided everything that could be desired in the way of data on correct practices in the welding and testing of such lines. It was more than a year before any considerable amount of data were available on which to base definite conclusions and fully two years passed before this engineer was willing to endorse publicity for the welded steam line. During this period what is known as the pressure-impact test was developed, this, as you know, being a test under cold water pressure to several times the pressure to be used in service, and the striking of the weld with a heavy sledge while the pressure is on. This was not all, however. Research and engineer work were diligently applied to the development of better filling materials, and further study was given to such matters as angles for chamfering and details of operating. To engineering and research work is due the development of practically every step in the favorable position the oxy-acetylene process occupies today in making joints which will be under stress or tension. Without the exacting demands of engineering and research work, adhesions and porous welds would not be, as is true today, the exception confined to the inexperienced or careless operator. It is under the guidance of the engineer first and last, and by the engineer is meant the chemical as well as mechanical engineer, that quality has been attained, quality that gives to the welded part in instances a greater strength than the base metal of equal section.

It seems only yesterday that we thought of cast iron as not being susceptible to cutting with the oxy-acetylene torch. We still consult text books which tell us that cast iron cannot be so cut, and every little while we read some such statement in the trade papers. I think it was within the past sixty days that one of the national trade publications in New York City published an article by one of its special correspondents in which the statement was made that cast iron could not be cut with the blowpipe. This article went on to state that for this reason chamfering was done with the pneumatic hammer and chisel. Yet I can point out many instances where the blowpipe was not only used for chamfering cast iron but was the result of considerable saving, in one case requiring only 40 minutes to perform an operation that otherwise would have required ten or twelve hours. If the oxygen consumption were measured against the cost of power for the penumatic hammer and chisel there is no doubt that the cost of the oxygen would seem excessive, but when the time element is taken into account this difference would be more than offset in economy, not with reference to the difference in cost of labor but because it permitted restoring a machine to operation hours earlier than otherwise would have been possible.

Still more recently there has come to my attention a report on the use of both the blowpipe and the pneumatic hammer and chisel in chamfering a cast-iron soaking pit cover, which had been cracked in service at one of the country's large steel mills. I do not know, but I have no doubt that the blowpipe in this instance was used to speed up the making of the chamfer and that the pneumatic hammer and chisel were used in finishing it. As you all know, one of the early objections advanced against chamfering with the blowpipe was the difficulty of securing a clean surface for the welder to work on. In the instance first noted the chamfering was done by an experienced operator and no chiseling was necessary. It is easy to understand, however, that smoothing up of the kerf with the cold chisel may be desir-

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*Extract from a paper read before the American Welding Society, Chicago Section, Chicago, Dec. 7, 1922.

†Oxweld Acetylene Company, Chicago.

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able in cases where a blowpipe cut has not been very nicely executed.

I had always believed, because I had read, that oxy-acetylene would not be applied to the cutting of risers on iron castings. Yet I note than an iron foundry in a middle Atlantic state has recently investigated the feasibility of using the oxy-acetylene process for cutting risers on certain types of iron castings, and that it is seriously considering making a particular class of castings with two large risers in the place of five small ones, as is now done, so oxy-acetylene fon cutting of iron risers may have a real working test.

There are many things which would, but for the engineer, react unfavorably and even very seriously for the oxy-acetylene industry. Let us have an example. A tube manufacturer in the East encountered difficulty in some of his welding. Some of the welding was good and sound and some of it was spongy and very weak. The matter was taken up with the manufacturer of the steel and with the welding apparatus manufacturer and the producers of the gases used at the plant. Everyone seemed satisfied that somebody else was at fault and it was not until research was carried into the laboratory of the gas supplier that the real source of trouble was finally established. Strips of the steel were connected up like blowout fuses and a 12-volt electric current of high amperage passed through them until the strips began to melt at their centers. The current was then switched off and the strips were observed in the process of cooling. The good steel cooled off without any change in appearance but the faulty steel threw off sparks and puffed, an action that had been observed when the unsatisfactory welds were made. After cooling, this sample was found to contain little holes and craters. The investigation indicated that the welding difficulties were not due to the oxy-acetylene flame or to the apparatus but to a difference in the characteristics of the steels. Incidentally the manufacturer of the steel was convinced of this and took back approximately a $70,000 shipment. As a result we now have what is known as the weldable steel specifications.

Occasionally the oxy-acetylene engineer meets with what appears to be a poser, something that rather upsets his calculations and disturbs his equanimity. He may find, for example, that a filling material of great purity is not as desirable for a certain use as a filling material of less purity, provided the impurities are of a particular kind and present in a particular quantity. Or he may encounter another sort of anomaly. For instance, in a certain city there is a manufacturer of motor valves who had standardized on the oxy-acetylene process for joining mild steel stems to the valve discs which are grey iron castings. The manufacturer's consumption of oxygen ran about twice that of acetylene. As you know the normal welding flame requires approximately equal volumes of the two gases, that is, not taking into account the oxygen supplied by the atmosphere. He had never been able to satisfactorily account for this abnormal gas ratio and accepted an offer of assistance from the engineering department of one of the supply companies with which he dealt. The operator who was sent to investigate the situation tried the neutral flame but was unable to get better results than were being obtained with the oxidizing flame. In the end the matter went to the laboratory which reported in reference to the oxidizing flame:

> "This excess oxygen would form some iron oxide on the steel stem and would combine with silicon of the cast iron to form silicon oxide. In both cases this oxidation would produce additional heat which would serve to speed up production."

Thus the theory of the neutral flame which for years has been considered as basic in our industry has encountered the exception which proves the rule. It may appear that there is no great service rendered by the engineer in this instance. It will be found, however, that truth is always service and especially so in reasearch work which makes the foundations of all scientific industries.

Just at the present time the oxy-acetylene engineer is engaged in various branches of the industry where his services are in demand. I think that we will all admit that he has satisfactorily solved the problems connected with the welding of small tanks and later with the welding of larger tanks and of still larger tanks. As the size of the tank increases new engineering factors are present for consideration. It is quite a reach from the metal drum or barrel to the metal tank which stands 30 ft. in height and has a diameter of 22 ft. with a capacity of more than 100,000 gallons. The latter are approximately the dimensions of a tank which was built about two years ago, and which has been in continuous service since that time. In the development from the small metal drum to this relatively great structure there had been various stages, each of which has represented work accomplished by the engineer. From the super-welded tank of two-years ago to the welded gas holder with a capacity of a million cubic feet or more, is seemingly a vastly further stride than from the metal drum to the hundred-thousand-gallon welded tank, yet I venture to predict that the engineer will feel his way step by step with welding, and that welded construction will one day be recognized as the best practice in the fabrication of even the largest gas holders. Some of the intermediate steps will be worked out, no doubt, in the natural gas and oil fields, and it is my understanding that experimental work is now in progress on this very class of construction. It is conceivable that the oxy-acetylene welded joint, which is now known to be stronger and tighter than any rivetted joint that can be made, will be adopted for tank cars. When that day comes and oxy-acetylene welding replaces rivetting in tank construction throughout the oil industry, even as it is now replacing screwed and coupled joints for pipe lines of all kinds, it is a safe venture that a large part of the 72,000,000 gallons of gasoline yearly lost through leakage and evaporation will be saved.

Doubtless most of us who are gathered here think of oxygen and acetylene only in their relation to welding and cutting. It is surprising how many applications there are in which the blowpipe is used, however, where no welding or cutting is done. Who but the engineer would work out an application of the oxy-acetylene process for the tempering of saws. It may be news to some of you that one of the largest saw manufacturers in the world uses this process exclusively for tempering the blades of hack-saws and band-saws, and by means of it has eliminated a very considerable percentage of the waste that formerly resulted from hard spots and discolorations, due to imperfect heat distribution in tempering. Perhaps those of you who have automobiles do not know that the oxy-acetylene blowpipe is used in many of the country's largest tire plants in the cleaning of tire molds. Now that I have mentioned it you might think that it is a simple operation that anyone might think of and carry out, but this apparently simple thing has been the subject of a great deal of diligent engineering study. I am halted at the very threshold of so broad a subject as I see spreading before me. A manufacturer of acetylene for many years employed as a slogan "The gas of a thousand uses." That was a figure of speech which may yet be found inadequate to indicate all the uses of this marvelous gas, especially if considered in conjunction with its industrial running mate, oxygen. Practically, every separate and individual use is a product of engineering.

I have entitled this paper "What Engineering has made of the Oxy-Acetylene Process." I might not inaptly have entitled it "What Oxy-Acetylene Engineers have made the Process do for Industry and for Mankind." In either case anything that I have said or could say would only present the barest suggestion of the subject's possibilities. However, if I have succeeded in marking out the connection between engineering and the development of the oxy-acetylene process, even in general terms, I have given expression to the thought I wish to bring out. In concluding let me say that if the oxy-acetylene process has arrived at its present stage of development step by step through the energies and efforts of the engineer, it is through the engineer also that it will make any future strides. This should not be forgotten. It should not be forgotten by the man who fancies he knows the limitations of the process, and it should not be forgotten by the man who thinks that anyone can do almost anything with it. The engineer is in the saddle, no less in the oxy-acetylene industry than in industry as a whole.

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Current Welding Literature

WELDED BONDS ON D. C. TRACK CIRCUITS, by C. F. Estwick—Describing operation of 0.7 ohm relay when applied to long track circuits. Making readings just after switch is thrown. Tests after welded bonds were installed. Installation of 0.7 ohm relay. Shunting tests. Operation of relay found to be satisfactory except that the shunting is not so good as it is on short track circuits.—Railway Signal Engineer, November.

INDUSTRIAL METHODS OF LIQUEFACTION AND THE PRACTICAL APPLICATION OF LOW TEMPERATURES, by K. S. Murray—Discussion of earlier methods of producing oxygen, leading to the story of the development of the liquid air process. Descriptions of the processes of Linde, Claude and Norton, with simplified diagrams of the apparatus used in each of these processes. Comparison of the principles involved in the construction and operation of each of these plants.—Industrial Gases, London, September.

AUTOMATIC ARC WELDING, by A. K. West—Applications of the process at the General Electric Company's Schenectady plant. Manufacturing solenoid brake wheels. Seam welding with the automatic machine. Repairing armature shafts. Speed of metal deposition of the automatic machine as compared to hand welding. —American Machinist, November 16.

FUTURE POSSIBILITIES OF WELDING, by B. C. Tracey—The body of this discussion is confined to a listing of the jobs which might well be accomplished by arc welding, in car repair and car construction.—Railway Electrical Engineer, November.

CUTTING CAST IRON, by A. S. Kinsey—Cast iron cutting is inclined to go slowly and is not so perfect as cutting soft steel. The kerf is wider and the surface of the cut is covered with a heavy oxide scale. The ignition spot must be bigger and hotter than for steel, and the preheating flame must be heavier. Analysis of costs shows that oxy-acetylene cutting costs only half as much as machine cutting on cast iron.—Railway Mechanical Engineer, December.

OXY-ACETYLENE WELDING AS APPLIED TO OIL PIPE LINES AND PUMPING STATIONS, by N. E. Wagner—Description of the welding of several pipe lines, telling how the crews were organized, equipped and supervised. Success in this work was the result of care in the selection of equipment, filler material, and good welders. Labor saving methods of handling large pipes. Interesting welding jobs at the pumping station.—Acetylene Journal, December.

LERNING THE TRAID, by David Baxter—Hints to the beginner on how to handle the torch, and the manipulation of the torch and filler rod.—Acetylene Journal, December.

ELECTRIC ARC WELDING OF CAST IRON, by W. H. Namack —Part II of a report prepared under the auspices of the American Bureau of Welding. The proposed program of research. Specifications for testing commercial electrodes. Preparation of samples and method of welding and testing. Charts and tables summarizing the results of tests.—Journal of A. W. S., November.

STANDARDS FOR RESISTANCE WELDING TRANSFORMERS. —Report of the Resistance Welding Committee.—Journal of A. W. S., November.

DAVIS-BOURNONVILLE COMPANY
was merged with
AIR REDUCTION SALES COMPANY
on March 17, 1922

The Oxyacetylene Welding and Cutting products formerly manufactured by Davis-Bournonville Co. are now made and sold by Air Reduction Sales Co. under the trade name of "Airco-Davis-Bournonville" or "Airco-D-B."

(See advertisement of Air Reduction Sales Co.)

News Items

At a meeting of the Chicago Section of the A. S. M. E., held at the Engineers' Club, Chicago, November 14th, a paper on the subject of fusion welding as applied to the construction of unfired pressure vessels, was read by Mr. Harry Sloan, president of the American Society of Refrigerating Engineers. Following the reading of the paper there was an open discussion, in which several of the local exponents of good welding made gallant efforts to remove the existing prejudices against the use of the process.

The Gibb Instrument Co., of Detroit, manufacturers of electric welding equipment, announces the removal of plant and offices to Bay City, Mich. For the past two years this company has concentrated on the development of automatic and semi-automatic arc, spot and seam welders.

The Compressed Gas Manufacturers' Association has issued a copyrighted bulletin of suggestions for cylinder testing. The purpose of the tests recommended is to provide a means of determining certain properties of cylinders which have not been revealed by previous test methods, and to develop charts and tables which will eliminate a great deal of arduous calculations.

The tenth annual meeting and dinner of the Compressed Gas Manufacturers' Association will be held at the Hotel Astor, New York, Monday, January 15, 1923. The meeting will be held at 2:00 P. M. and the dinner at 7:00 P. M.

The Wilson Welder & Metals Co. are now represented exclusively in Maryland, Virginia and the District of Columbia by the Alexander Milburn Company, of Baltimore. A large stock of welding wire and arc welding machinery is reported to be available at this point for distribution throughout the territory, and a complete demonstration plant is in operation.

Mr. A. A. Heller has taken over the management of the International Oxygen Company, Newark, N. J., in place of Mr. L. W. Hench, secretary and general manager, resigned.

The U. S. Gauge Company announce the appointment of Mr. Wm. Rapp as manager of the district office at Chicago. Mr. Rapp served the company at this office during the period of 1914 to 1918, and therefore has a large acquaintance in the territory over which he assumes jurisdiction.

It is reported that the American Welding Co., Carbondale, Pa., will shortly start the production of a new heavy tractor, and contemplates the erection of a foundry and machine shop.

The Lander Welding Co., 41 Chester Street, Malden, Mass., has plans under way for the erection of a new manufacturing building.

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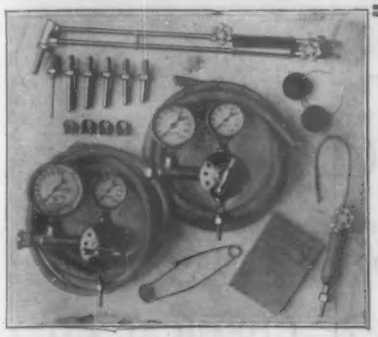

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1 Safety Torch Lighter	.50	
1 No. 30 Safety Front Oxygen Regulator with one 3,000-lb. Gauge, registering cu. ft. and one 300-lb. Gauge	24.00	
1 No. 35 Acetylene Regulator, equipped with one 300-lb. Gauge and one 50-lb. Gauge	18.00	
1 Length of 5-ply Oxygen Hose, 12½ ft.		$ 1.50
1 Length of 5-ply Acetylene Hose, 12½ ft.		1.50
4 Hose Clamps		.20
1 Pair Welding Goggles		.50
1 Instruction Book		1.00
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3 Cast Iron Rods, 3 Brass Rods, 3 Aluminum Rods, 10 Steel Rods	1 Pound Cast Iron Flux, 1 Pound Brass Flux, 1 Pound Aluminum Flux	3.00
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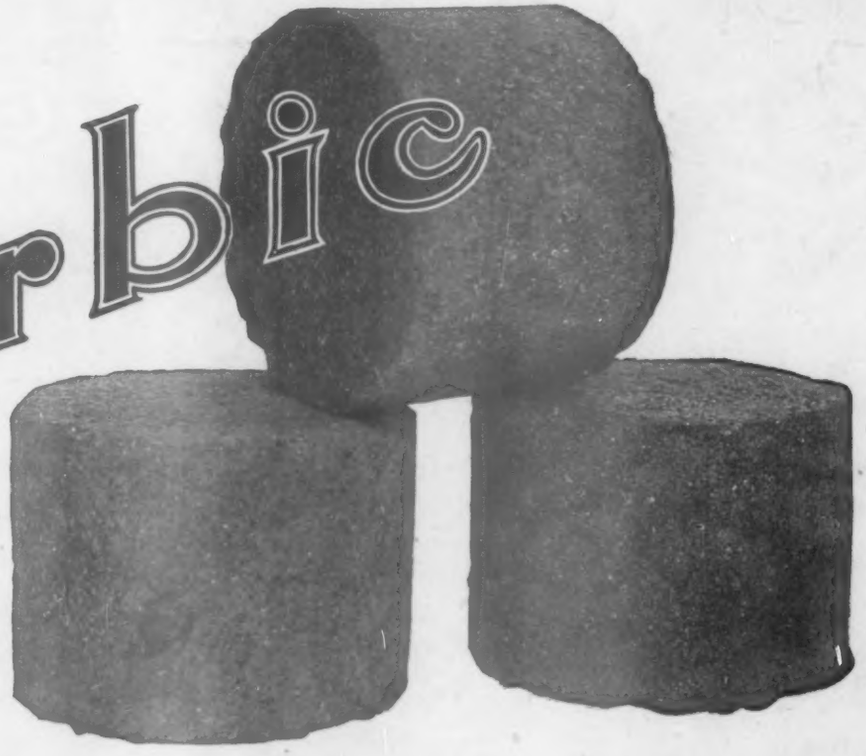

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